

Final Report Presentation

Single Axis Solar Tracker

For Prama Instruments Pvt Ltd

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Chittaranjan Sir

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PRAMA
Instruments Pvt. Ltd.

Solar Tracker



- A Solar tracker is a device used for orienting solar photovoltaic panel or lens towards the sun by using the solar or light sensors connected with the machine like linear actuator.
- Hence, the sun tracking systems can collect more energy than what a fixed panel systems collects.

Types of Solar Trackers

The sun's position in the sky varies both with the seasons (elevation) and time of the day as the sun moves across the sky. Hence there are two types of Solar Tracker:

Single Axis Solar Tracker:

Single Axis Solar Trackers can either have a horizontal or a vertical axle.

They are mostly built for tracking the sun from east to west direction.

Dual Axis Solar Tracker:

Double axis solar trackers have both a horizontal and vertical axle and so can track the sun's motion exactly anywhere in the world.

Single Axis Solar Tracker

- Single axis trackers are a technology that adjusts the position of a solar panel along an axis to follow the sun's changing position throughout the passing days and years.
- The panel is adjusted to create the smallest angle of incidence (angle at which the sun hits a solar panel).
- The trackers tilt on a singular axis to follow the sun from east to west as it moves throughout the course of each day in order to maximize energy production.

Single Axis Solar Tracker

Our Initial Vision for the Project



Make the Solar Tracker Package
as inexpensive as possible.



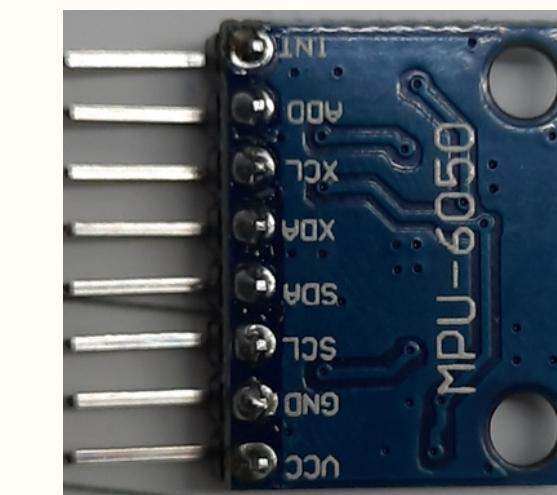
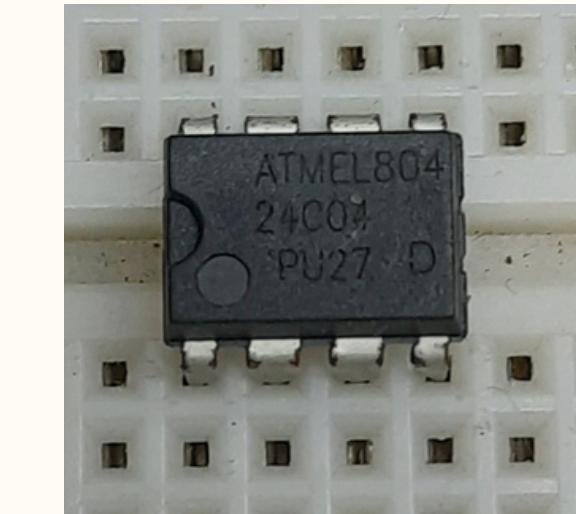
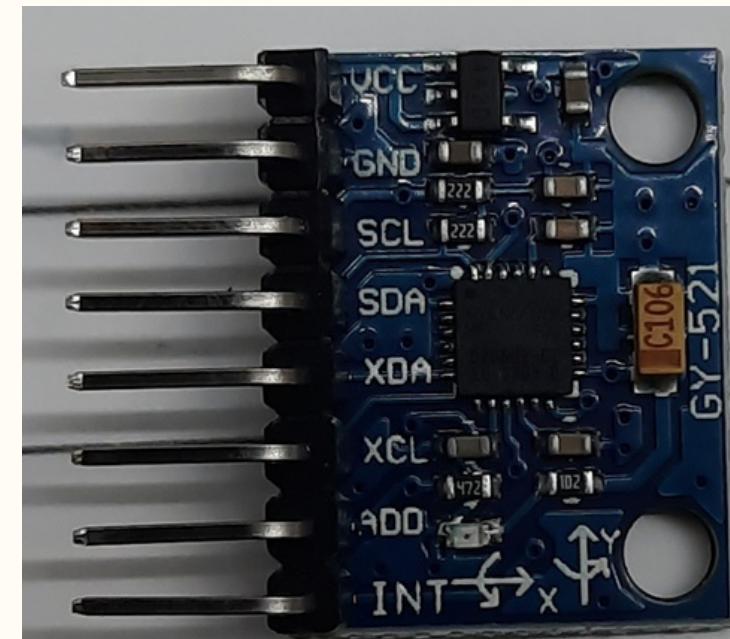
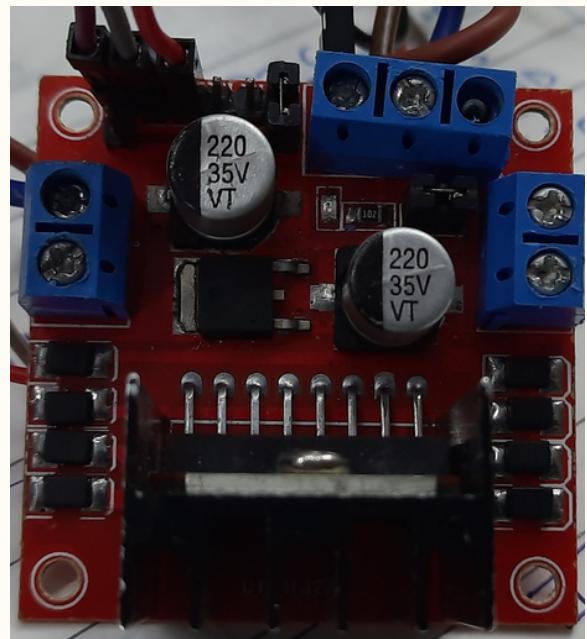
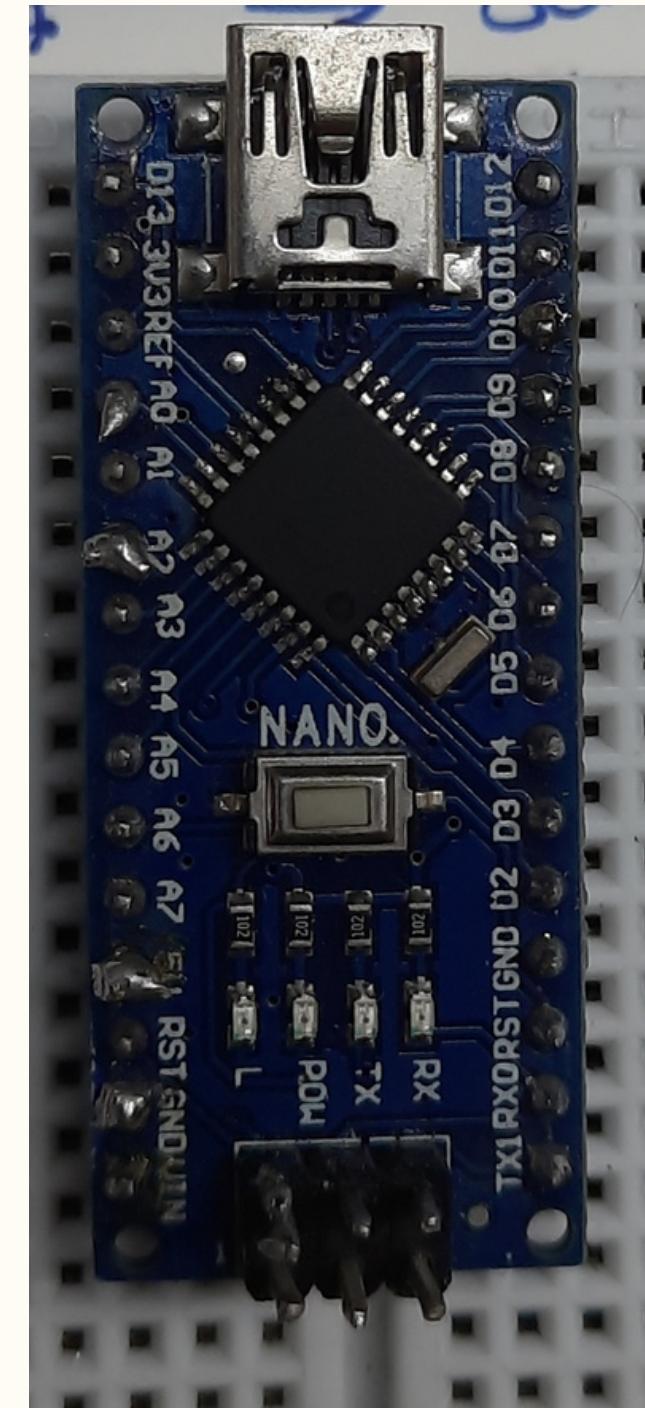
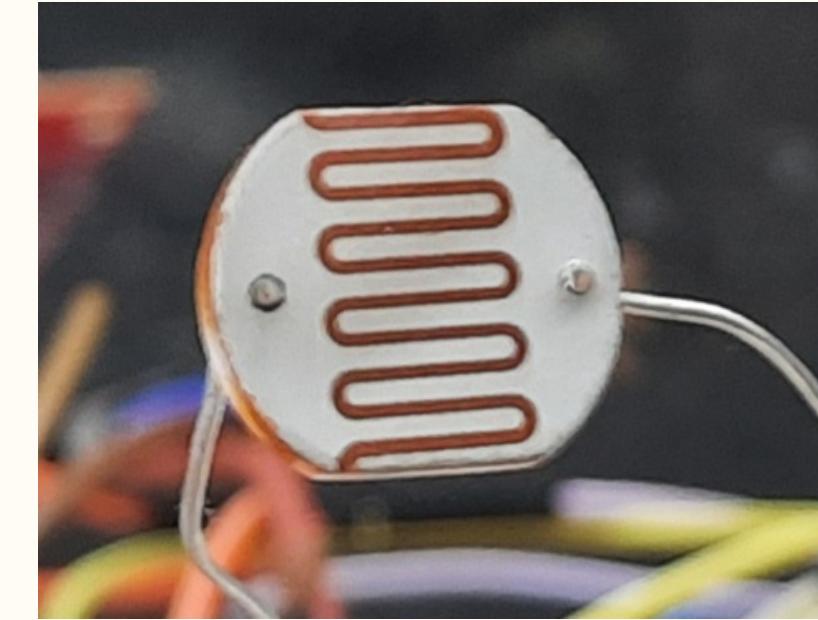
Make it easy to install for a
layman installing a Solar Panel.



Increase the efficiency of the
Solar Panel in terms of
Power generated.



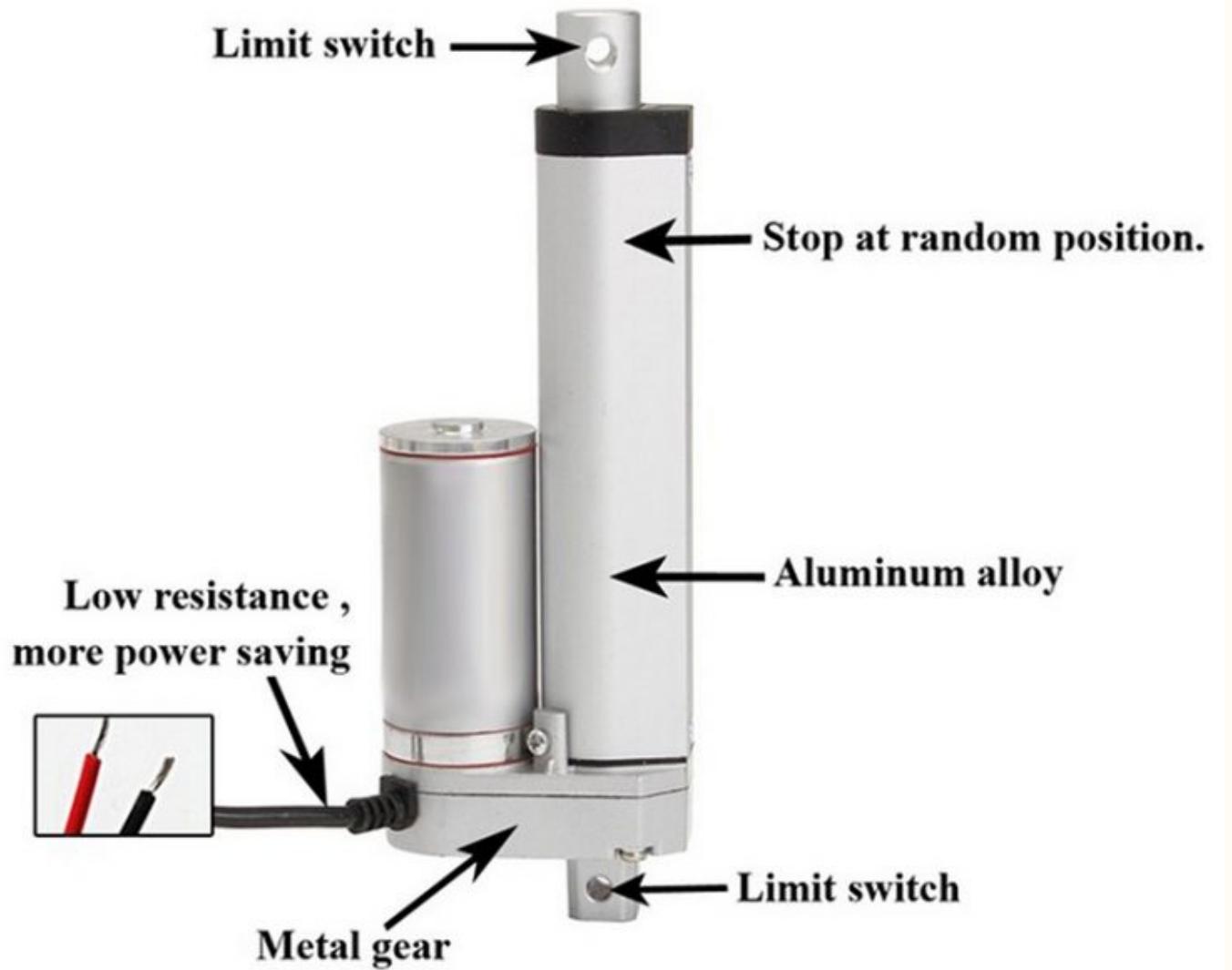
Make it a way of being more
sustainable and more efficient
way of Electricity generation.



Linear Actuator

To change the angle at which the Solar Panel faces the Sun.

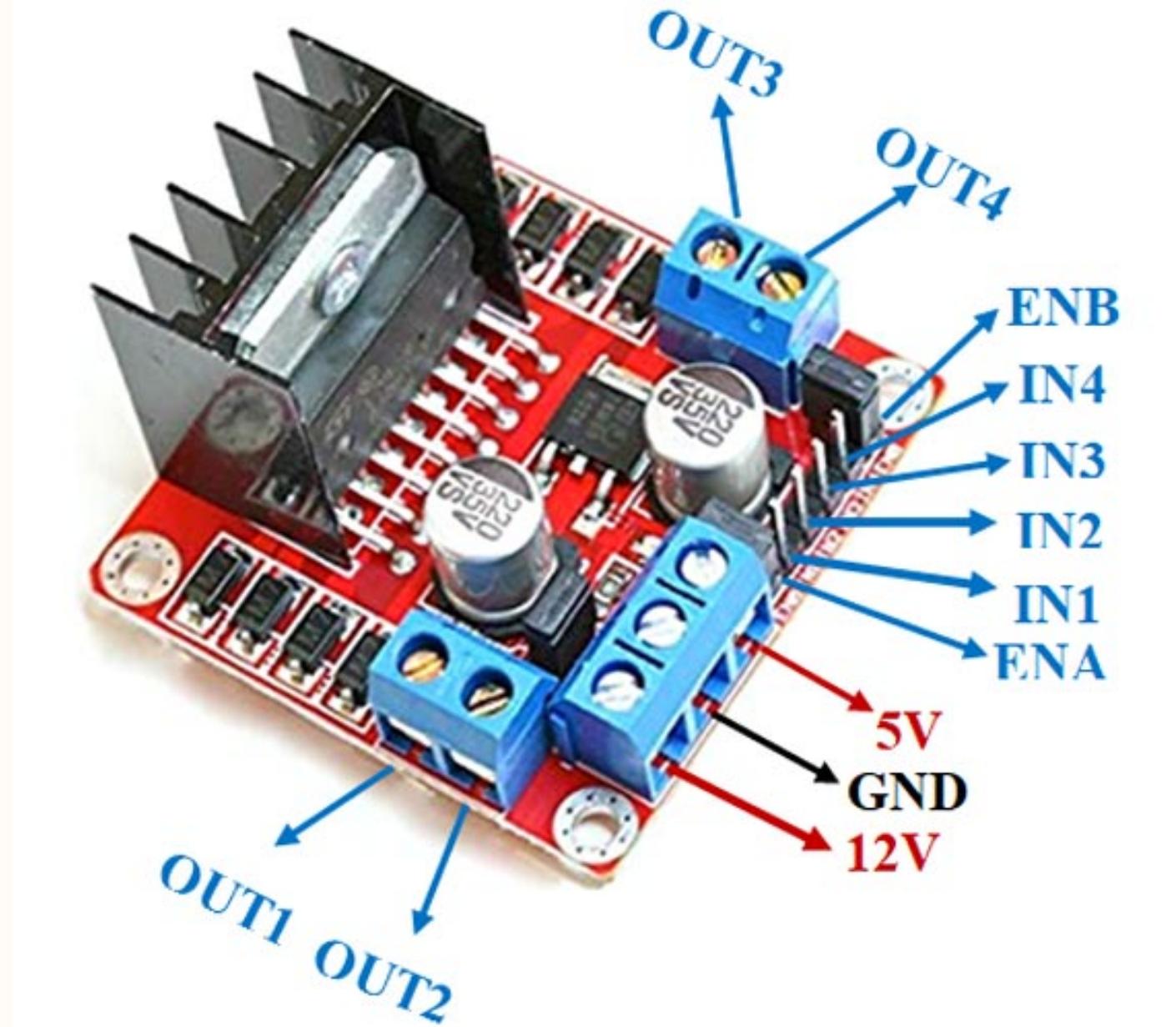
This electric push rod is a kind of electric driving device which transforms the rotary motion of the motor into the linear reciprocating motion of the pushrod.



Motor Driver L298N

To control the movement of Linear Actuator.

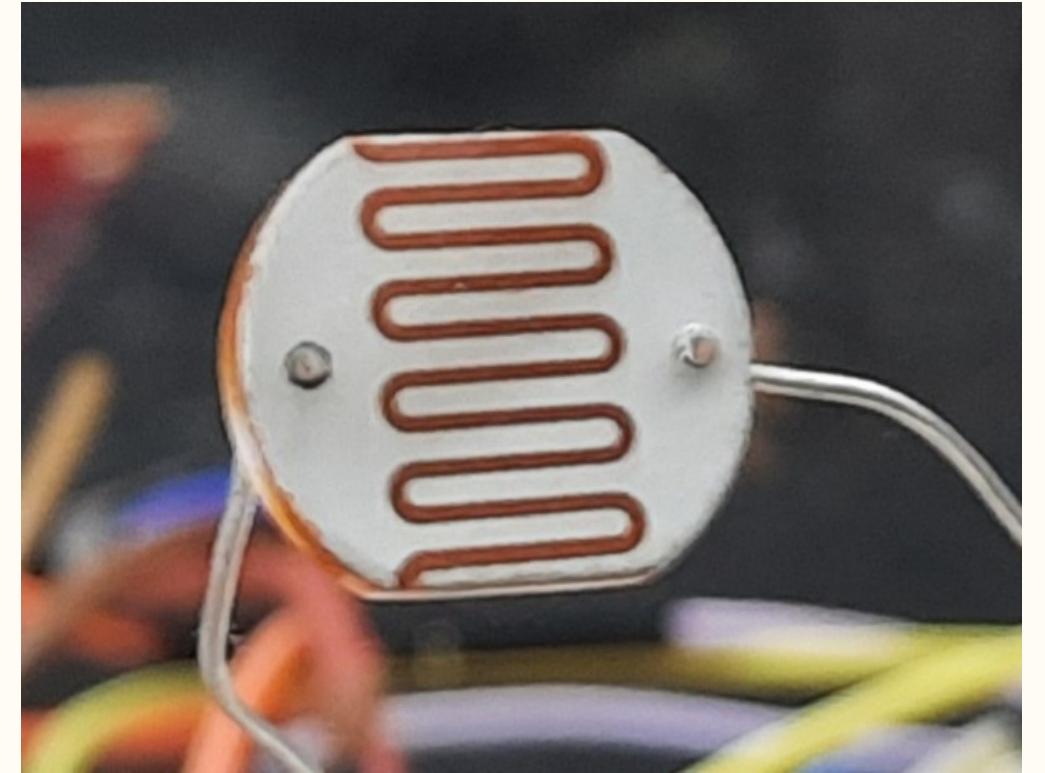
L298N 2A Based Motor Driver is a high power motor driver perfect for driving DC Motors and Stepper Motors .



Light Dependent Resistor

To find the intensity of sunlight falling on the Solar Panel.

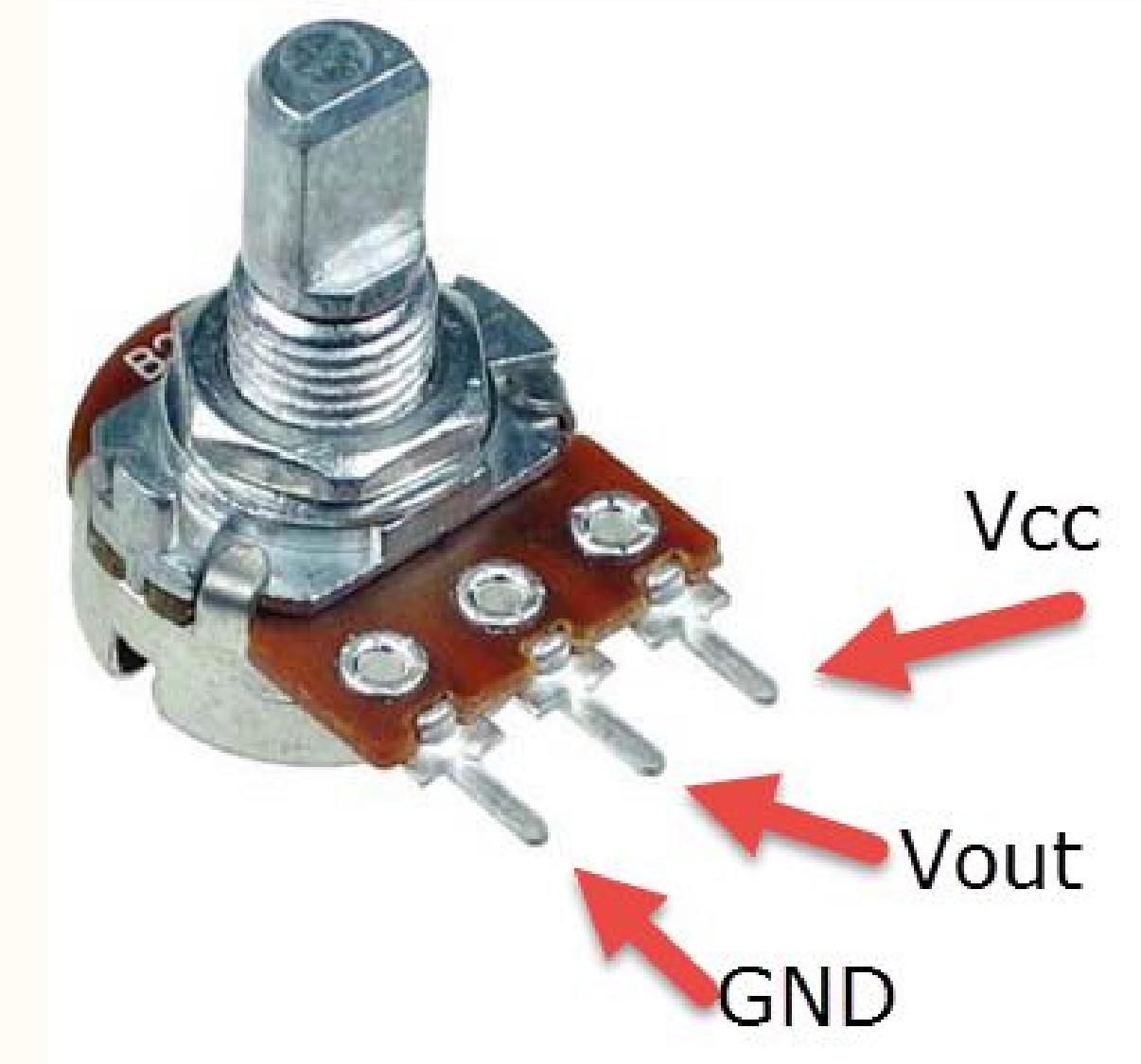
The resistance of 20mm GL20528 Light Sensitive Photoresistor LDR changes with the change in the ambient light exposed on the surface of the sensor. As the light on the sensor increases then the resistance across the two leads decreases.



Potentiometer

To find the potentiometer reading for controlling linear actuator.

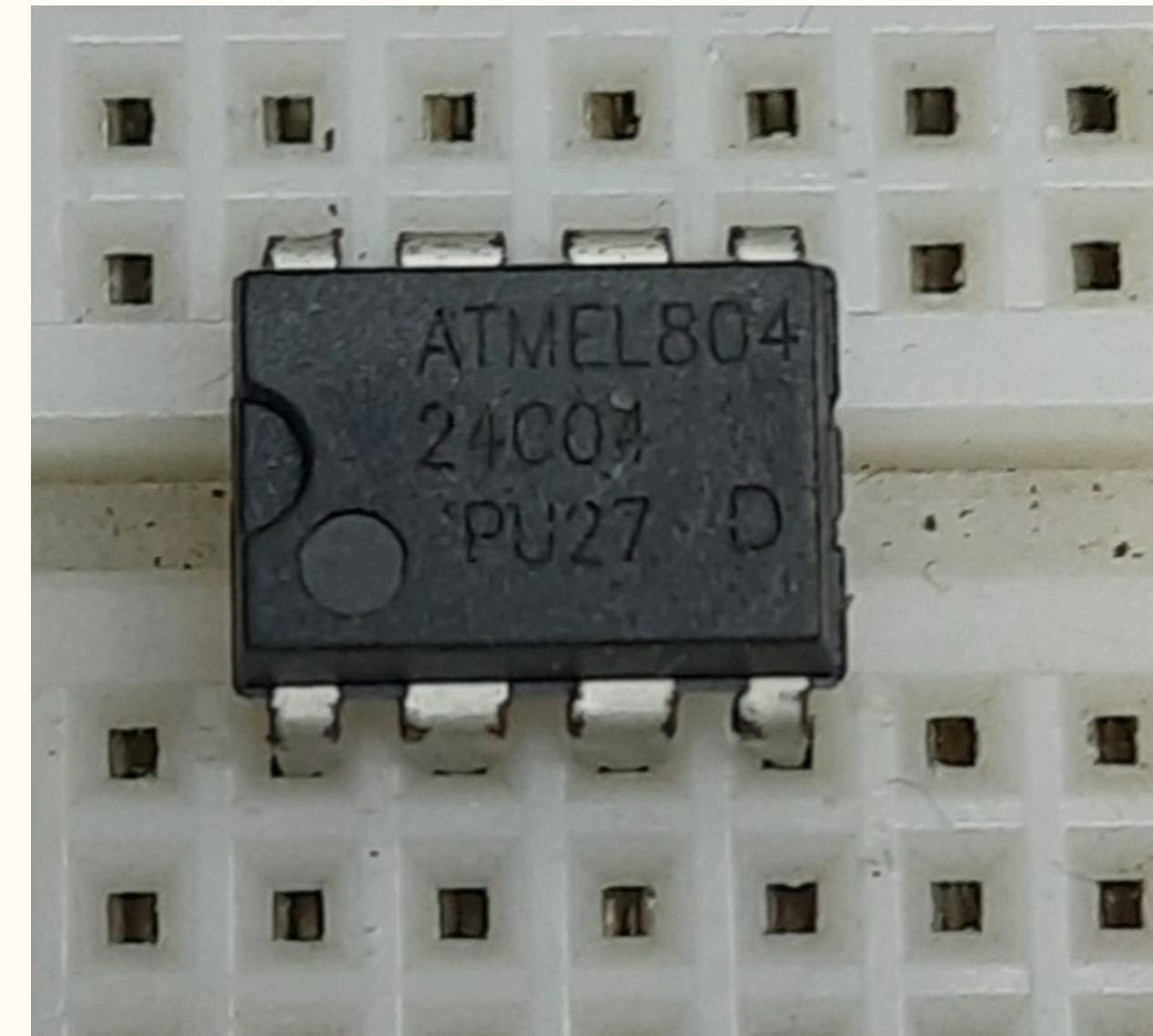
A potentiometer (also known as a pot or potmeter) is defined as a 3 terminal variable resistor in which the resistance is manually varied to control the flow of electric current. A potentiometer acts as an adjustable voltage divider.



24C04 EEPROM

To save data from Arduino and keep the data safe even when switch is off.

If you need to do some data storage in Arduino, then using the EEPROM is probably the most simple practices.

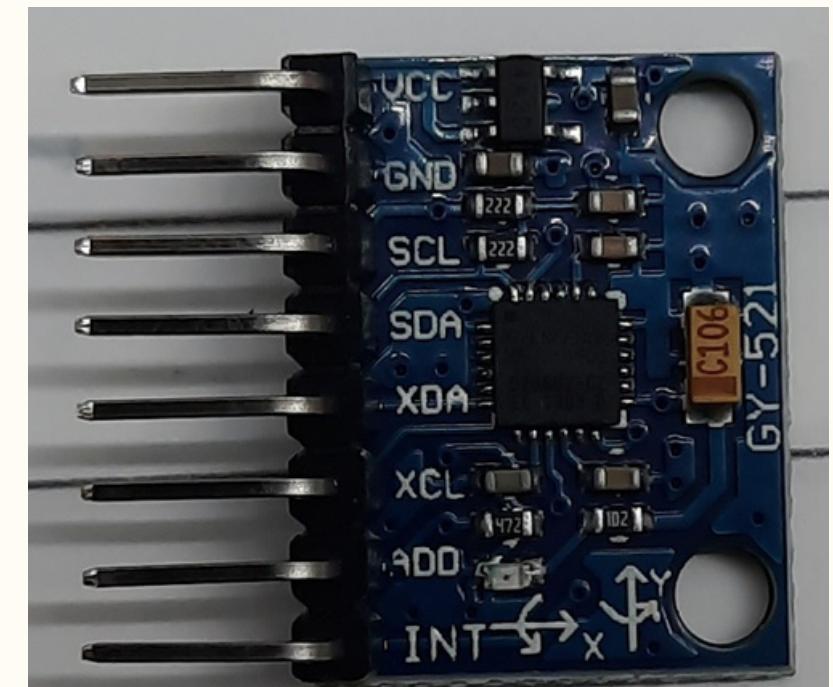
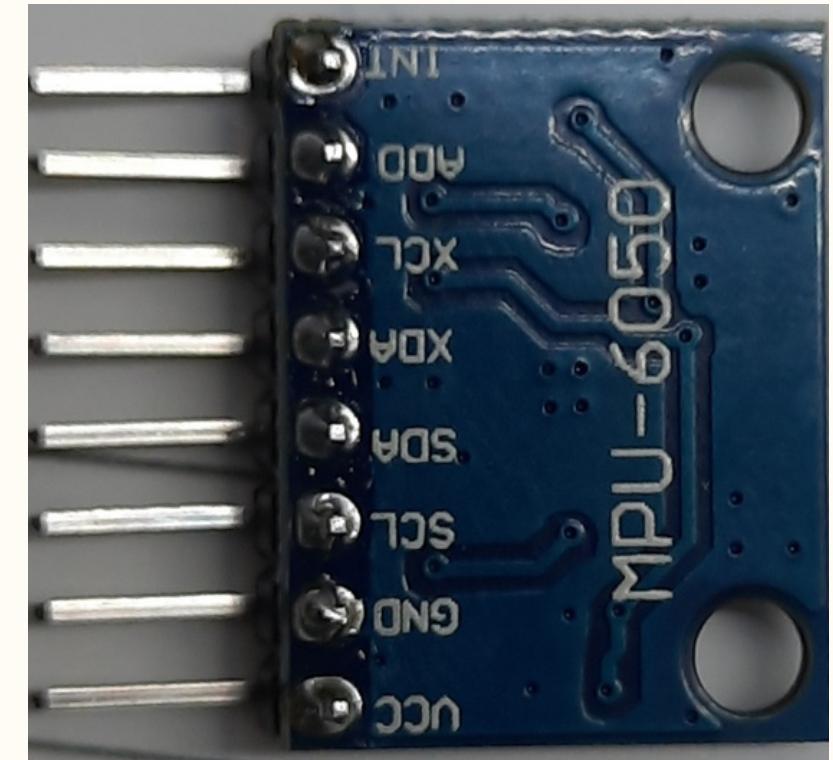


MPU-6050

3-Axis Accelerometer and Gyro Sensor

To measure the inclination of the panel with respect to the horizontal plane.

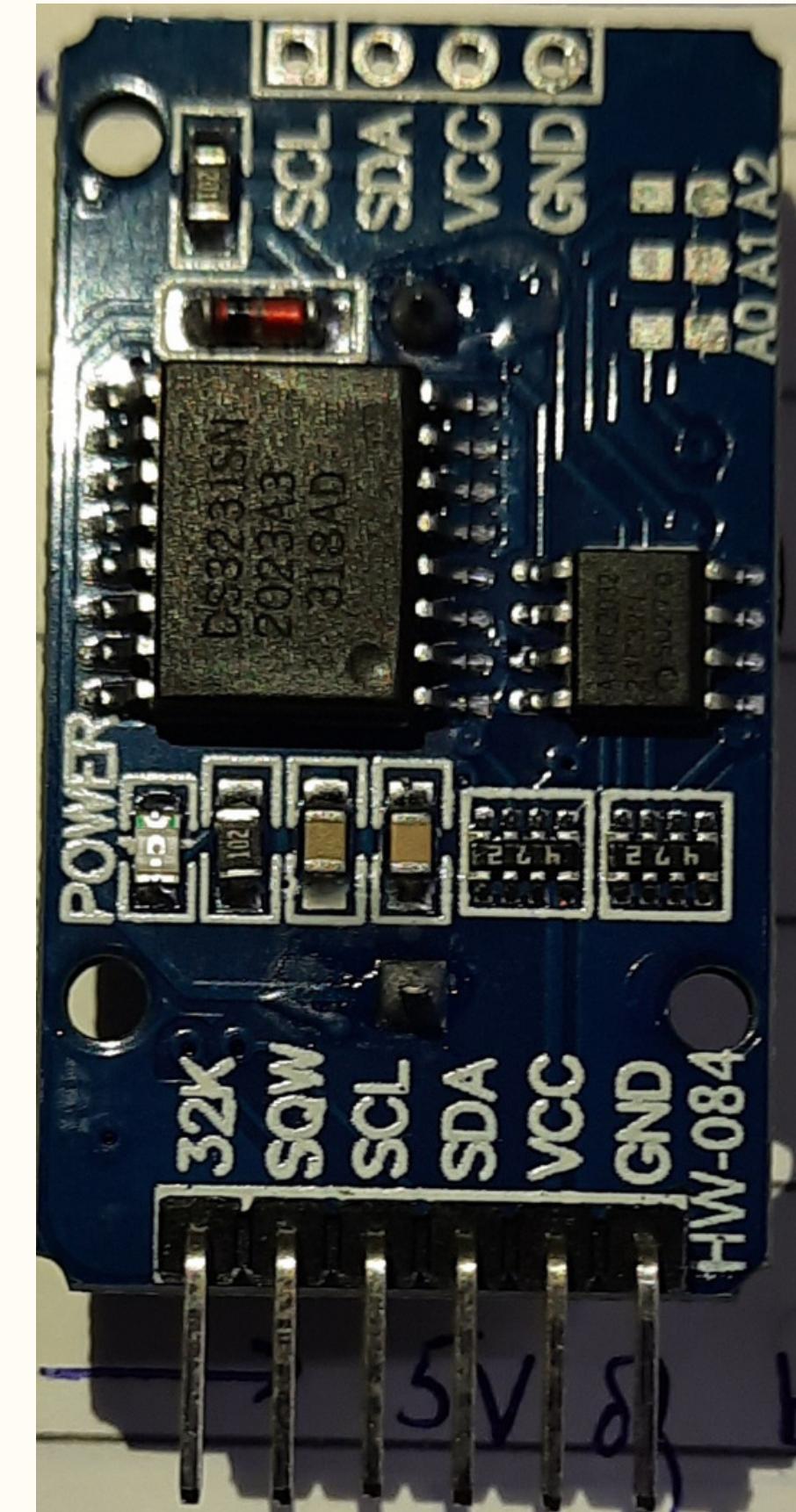
The MPU6050 devices combine a 3-axis gyroscope and a 3-axis accelerometer on the same silicon together with an onboard Digital Motion Processor (DMP) capable of processing complex 9-axis MotionFusion algorithms.



DS3231 RTC chip(Real Time Clock Module)

To have an external clock to synchronise time over all components even when the microcontroller is switched off.

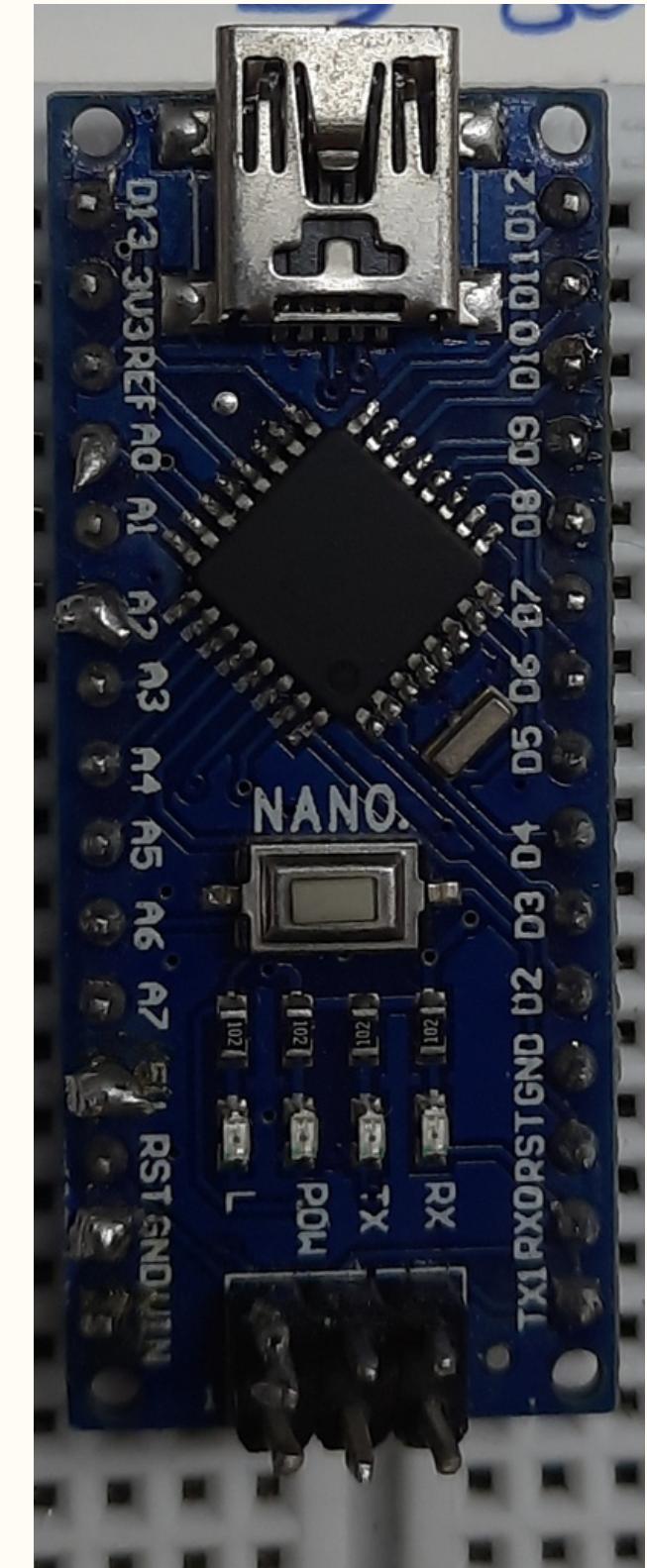
A real-time clock (RTC) is an IC that keeps an updated track of the current time. This information can be read by a microprocessor, usually over a serial interface to facilitate the software performing functions that are time dependent.

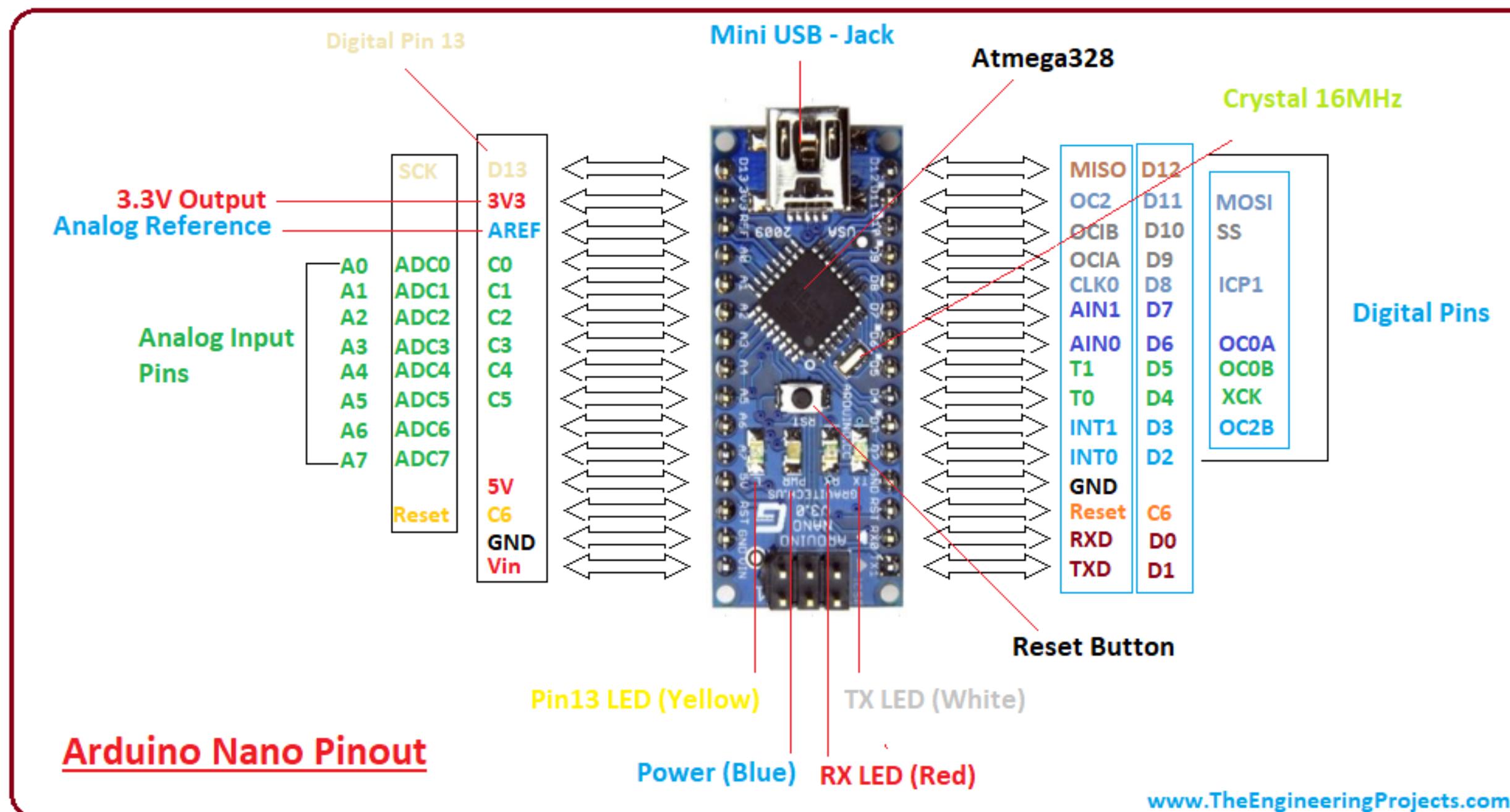


Arduino Nano

A microcontroller used to process data given and give appropriate output.

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is the smallest, complete, and breadboard-friendly.



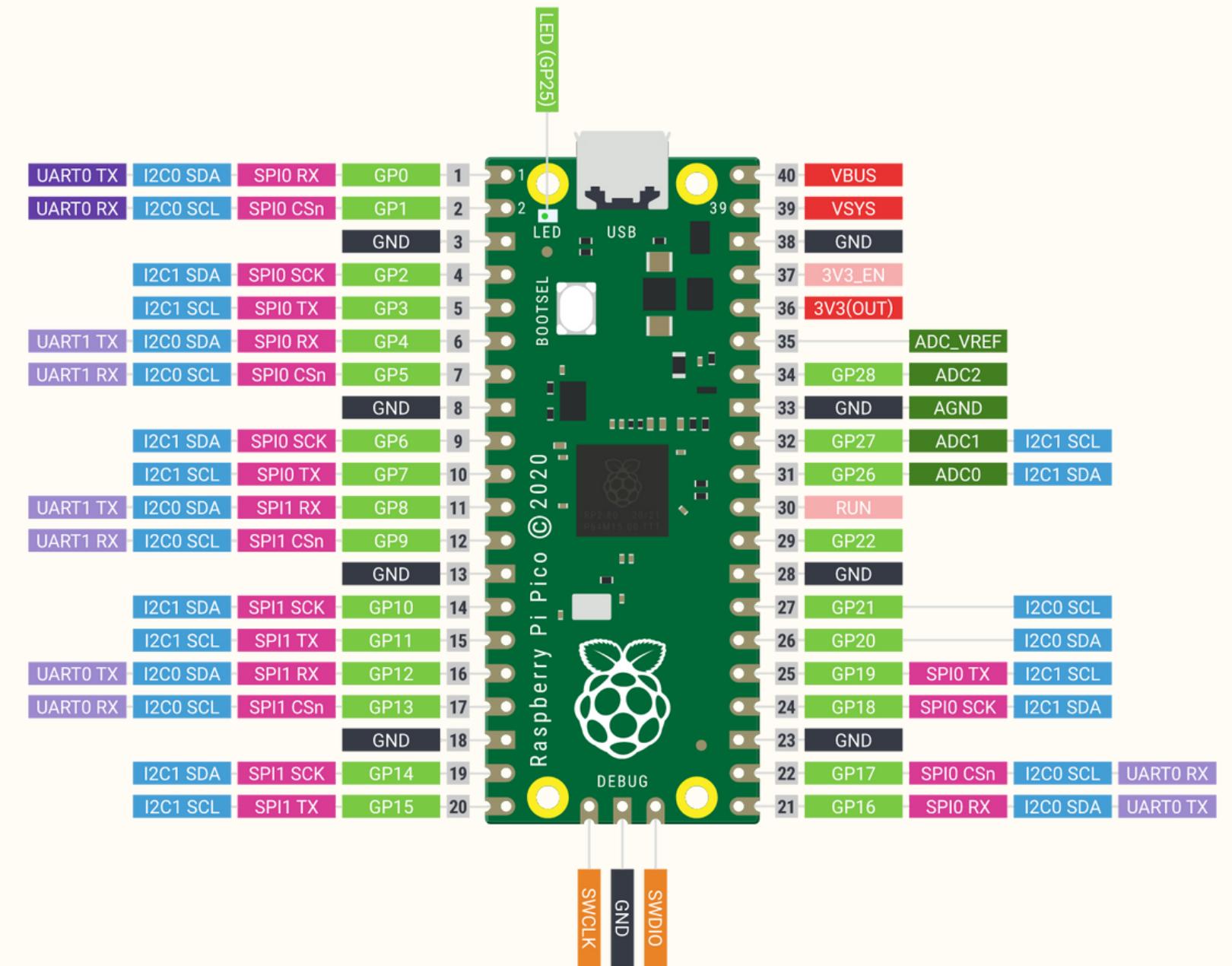


Raspberry Pi Pico

A microcontroller used to process data given and give appropriate output.

It is equipped with an RP2040 Microcontroller chip developed by Raspberry Pi Foundation itself. RP2040 is their first dual-core ARM Cortex M0+ processor-based latest small-sized, budget-friendly microcontroller.





Raspberry Pi Pico Pinout Description

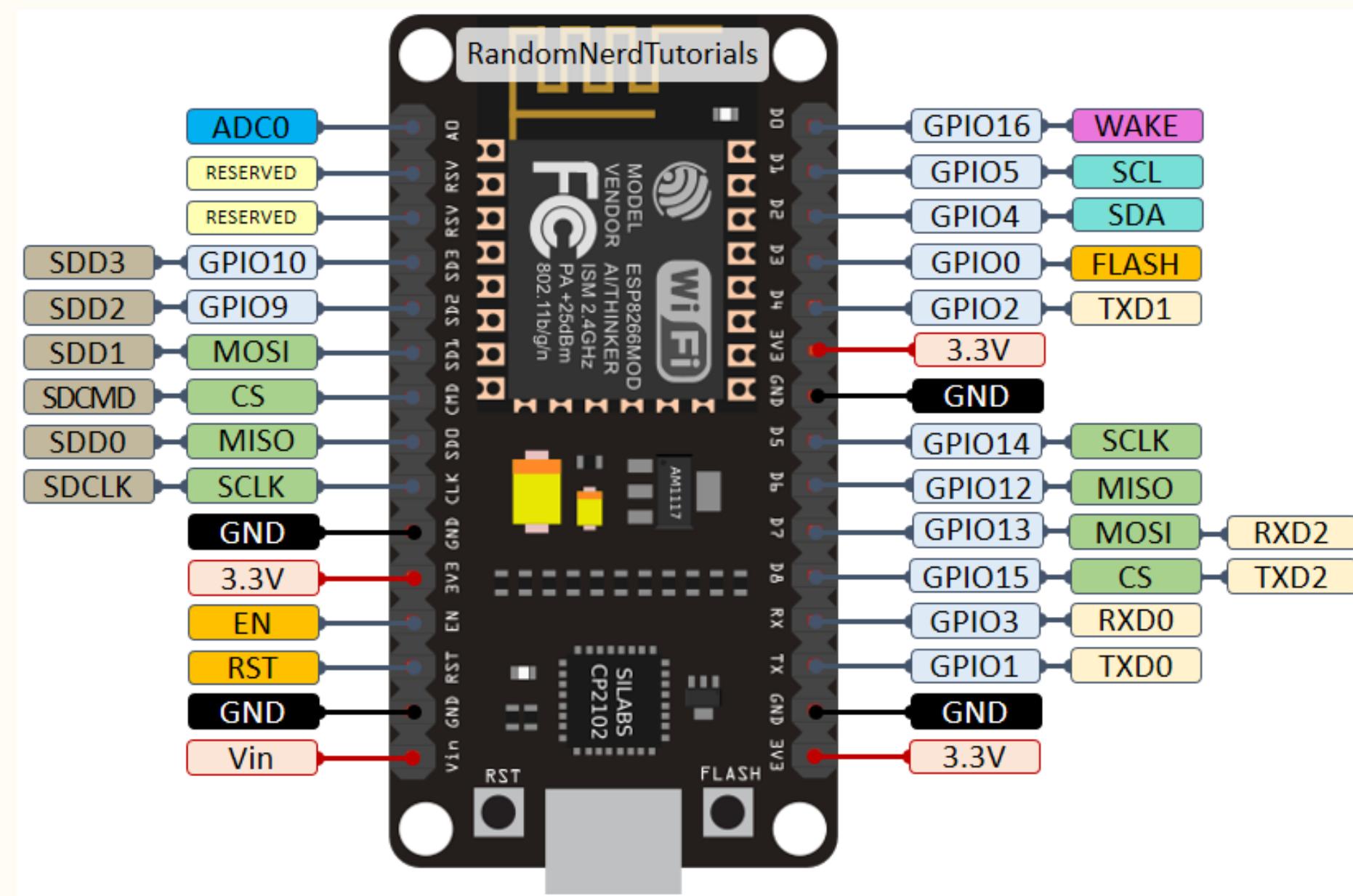
Why Pico over Nano?

- Better Processing Speed(138 MHz Vs 20 MHz)
- More Memory (264 kb Vs 48 kb)
- More Input/Output Devices
(2x UART, 2x SPI, 2xI2C, 16x PWM, 3x Analog
Vs 1x UART, 1x SPI, 1xI2C, 5x PWM, 8x Analog)
- Cheaper(₹349 Vs ₹759)
- Unavailability of Arduino Nano in Semiconductor Market

ESP8266 – WiFi Module

The ESP8266 NodeMCU CP2102 board has ESP8266 which is a highly integrated chip designed for the needs of a new connected world. It offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

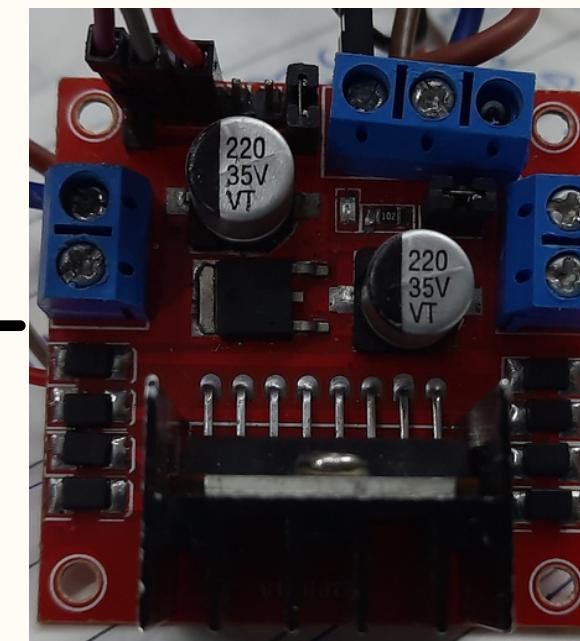




ESP8266 Pinout Description

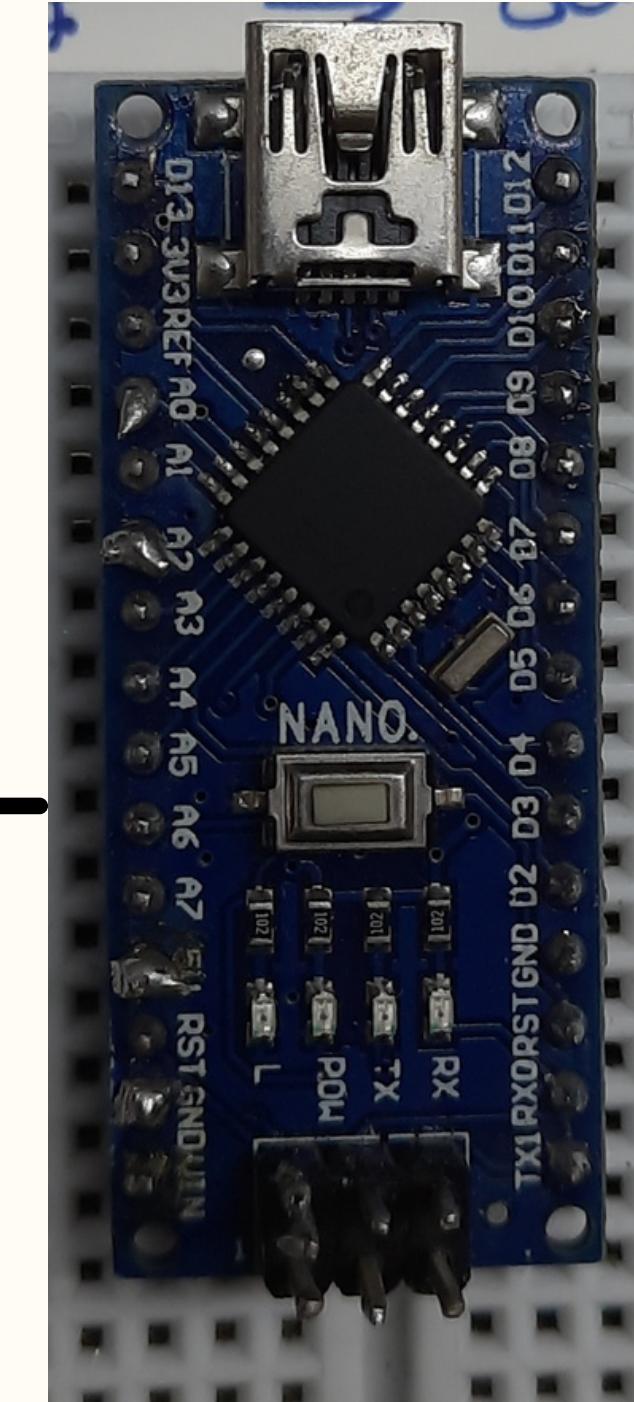
Flowchart of Connections

Version 1.0-Simplest Tracker

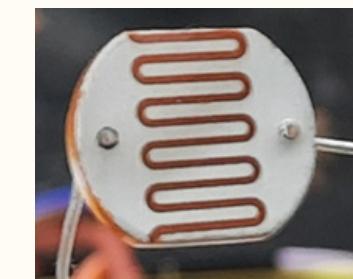


Motor Driver

Linear Actuator



Arduino Nano

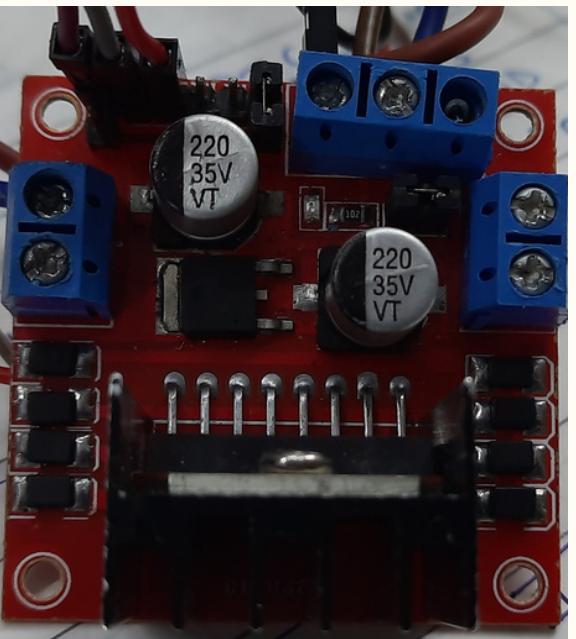


Light Dependent Resistors

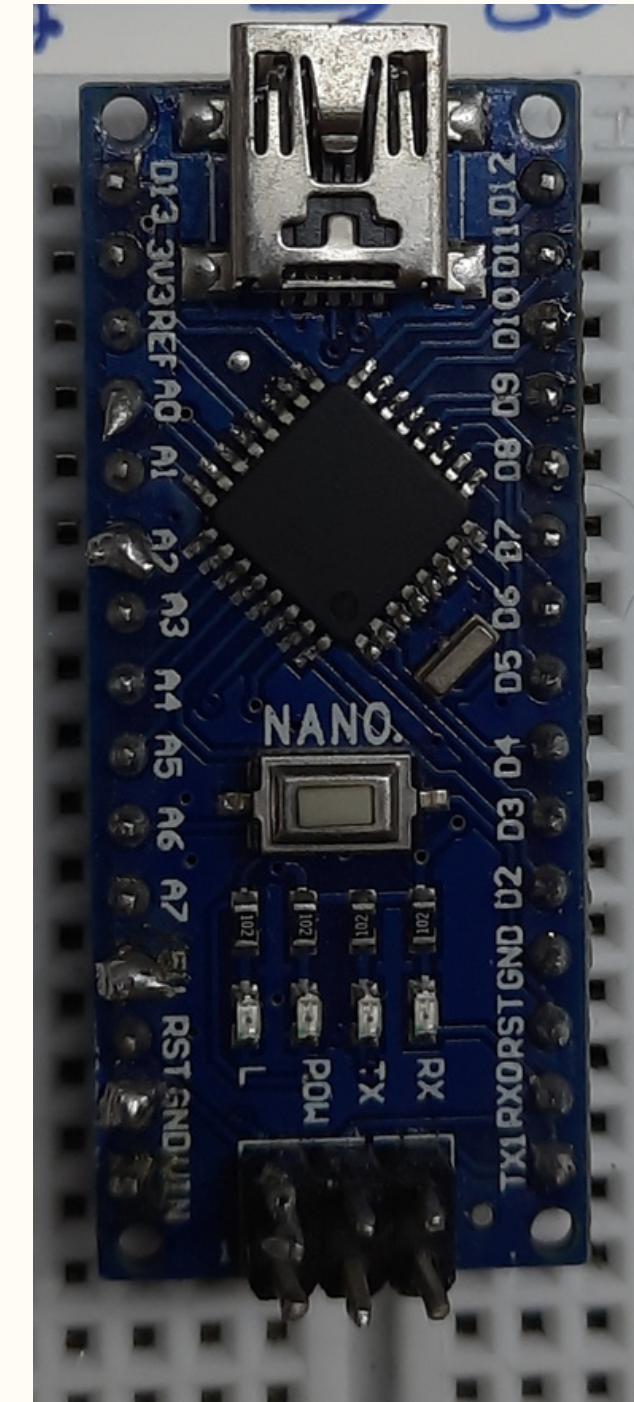
Version 2.0-Simple Tracker



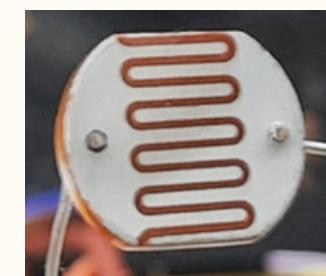
Linear Actuator



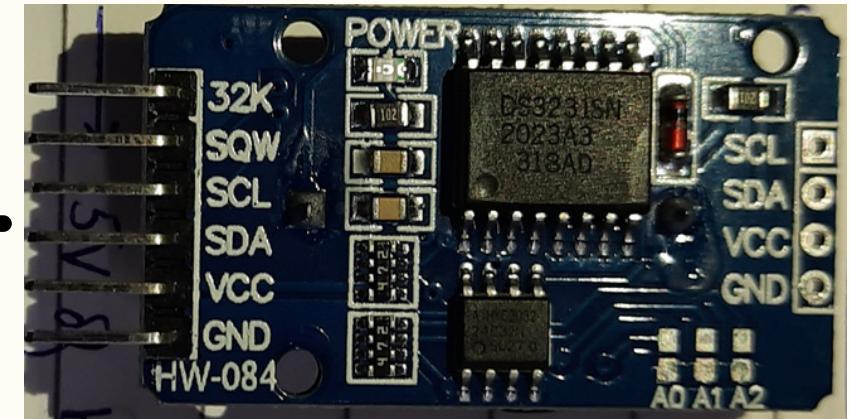
Motor Driver



Arduino Nano



Light Dependent Resistors



Real Time Clock Module
DS3231 RTC chip

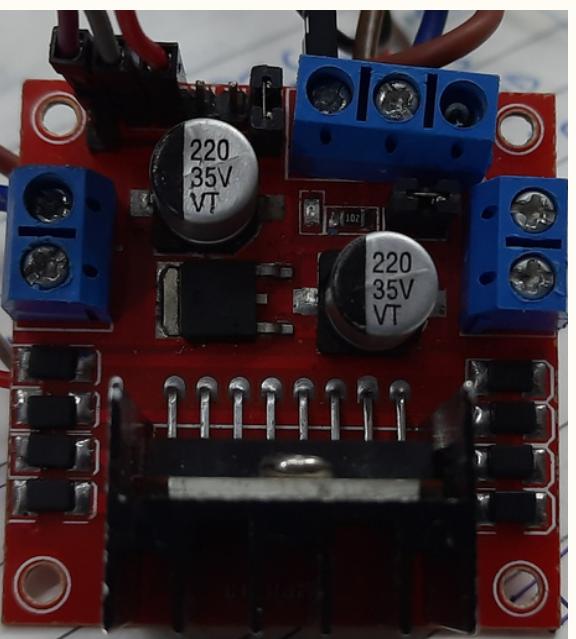
Function of RTC

Sleep Mode Initiation along with Homing

- We all know that Solar panels cannot generate electricity after sunset.
- Therefore, to avoid optimization of the actuator during night time is made sure by the Real Time Clock Module which halts the work of the tracker during the specified night hours.
- The Panel is homed when the night hour starts,i.e. the panel is brought in a resting position to be kept in night.
- This functionality can be added in all the version of the Solar tracker to avoid wastage of power in optimising the position of Solar Panel.



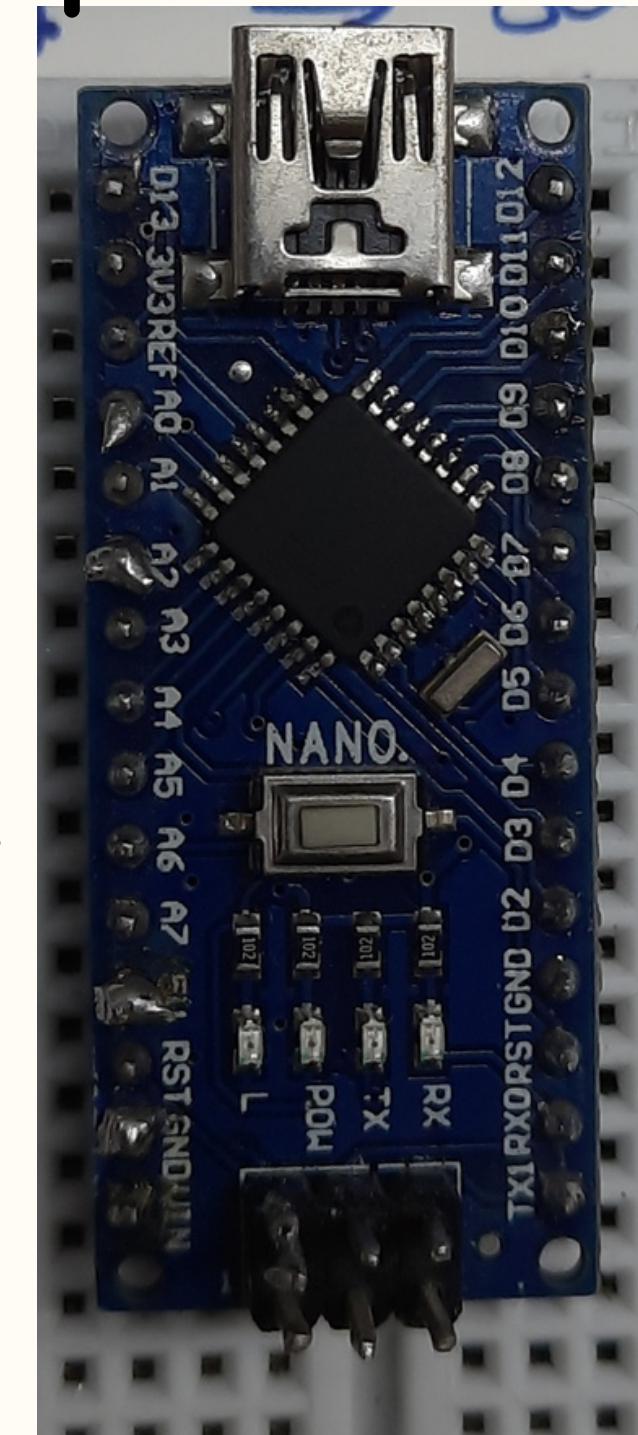
Motor Driver



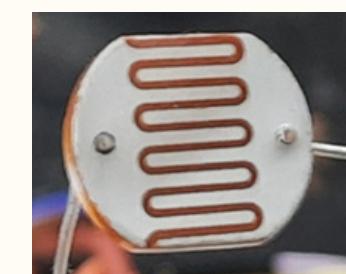
24C04 EEPROM



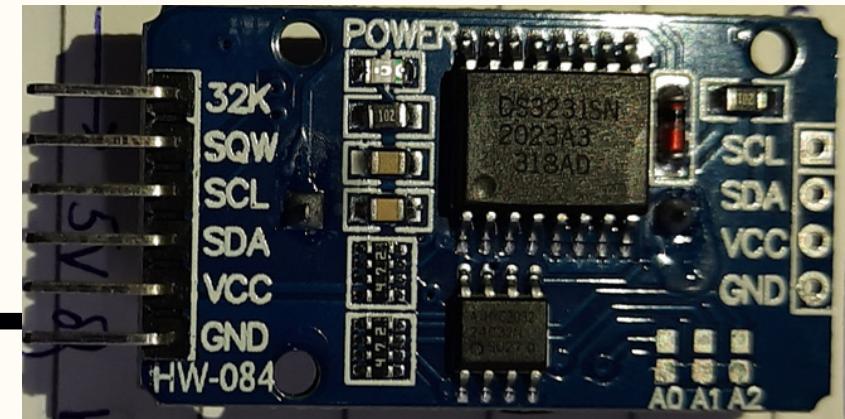
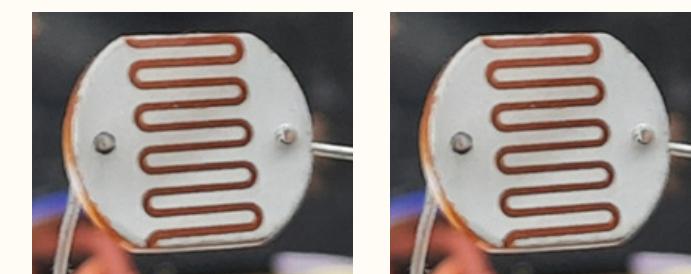
**Version 3.0-Nano
With MPU6050**



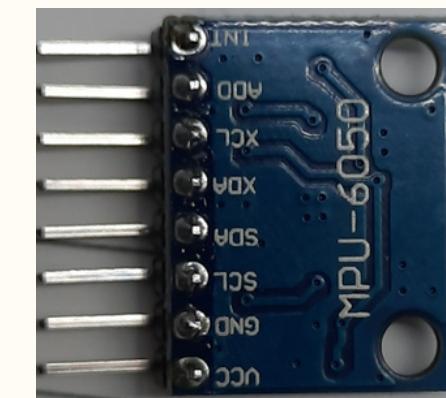
Arduino Nano



Light Dependent Resistors



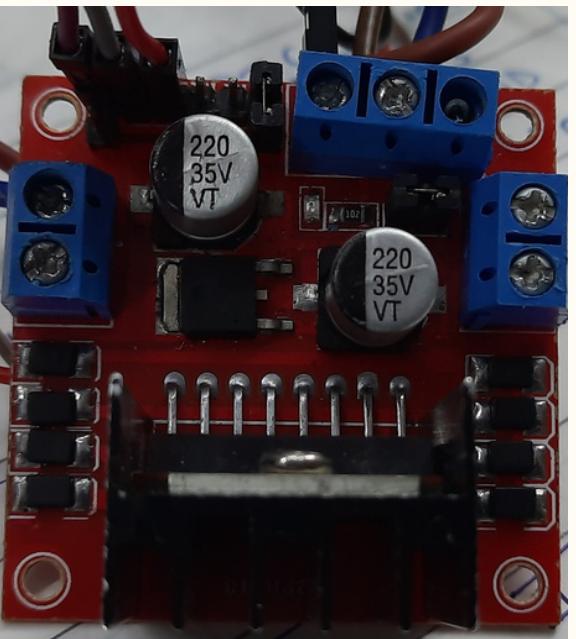
DS3231 RTC chip
Real Time Clock Module



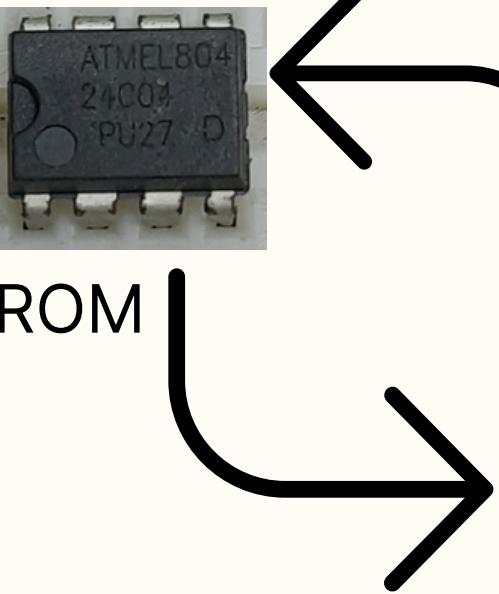
MPU6050 sensor
3-axis Gyroscope and 3-axis Accelerometer



Linear Actuator



Motor Driver



24C04 EEPROM

Version 3.1-Pico With
MPU6050

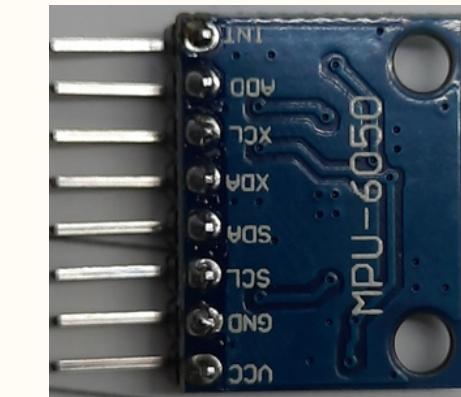


Raspberry Pi Pico



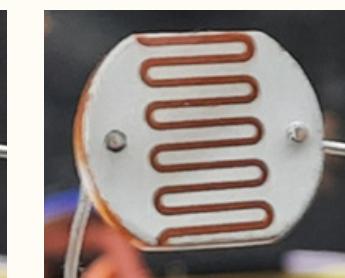
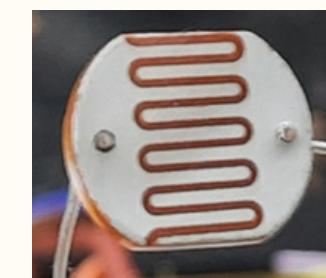
DS3231 RTC chip

Real Time Clock Module



MPU6050 sensor

3-axis Gyroscope and 3-axis Accelerometer



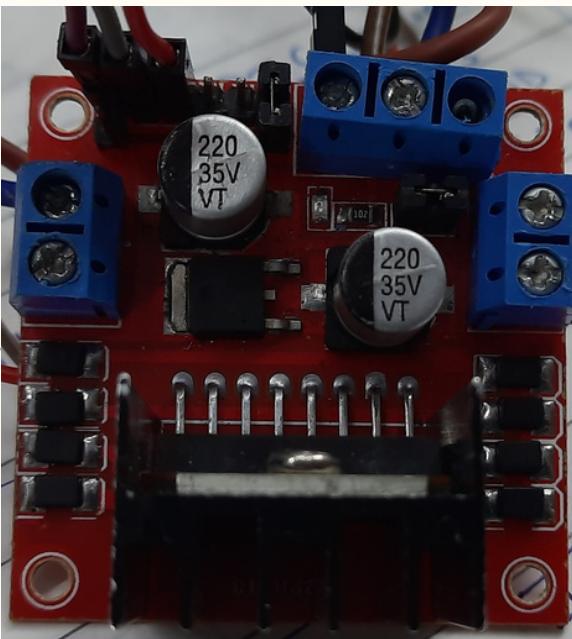
Light Dependent Resistors

Working

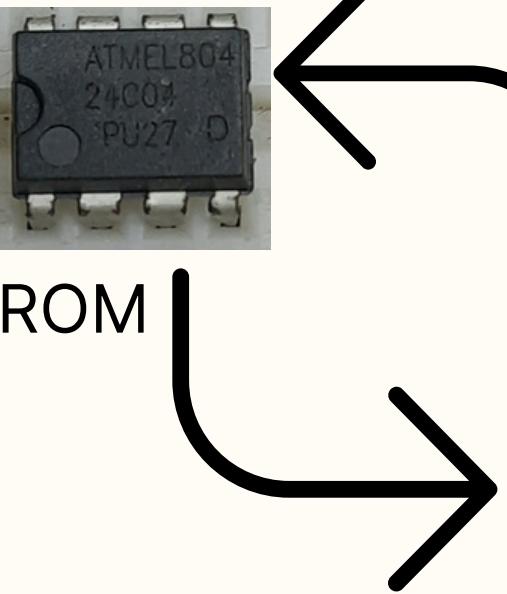
- In Calibration Mode, the change made in the reading of MPU6050 is stored in EEPROM, when the linear actuator moves according to the difference found in LDR readings.
- For Daily Mode, the reading along with the time is read and the linear actuator is commanded to optimize Solar Panel's position, ignoring LDR readings.



Linear Actuator

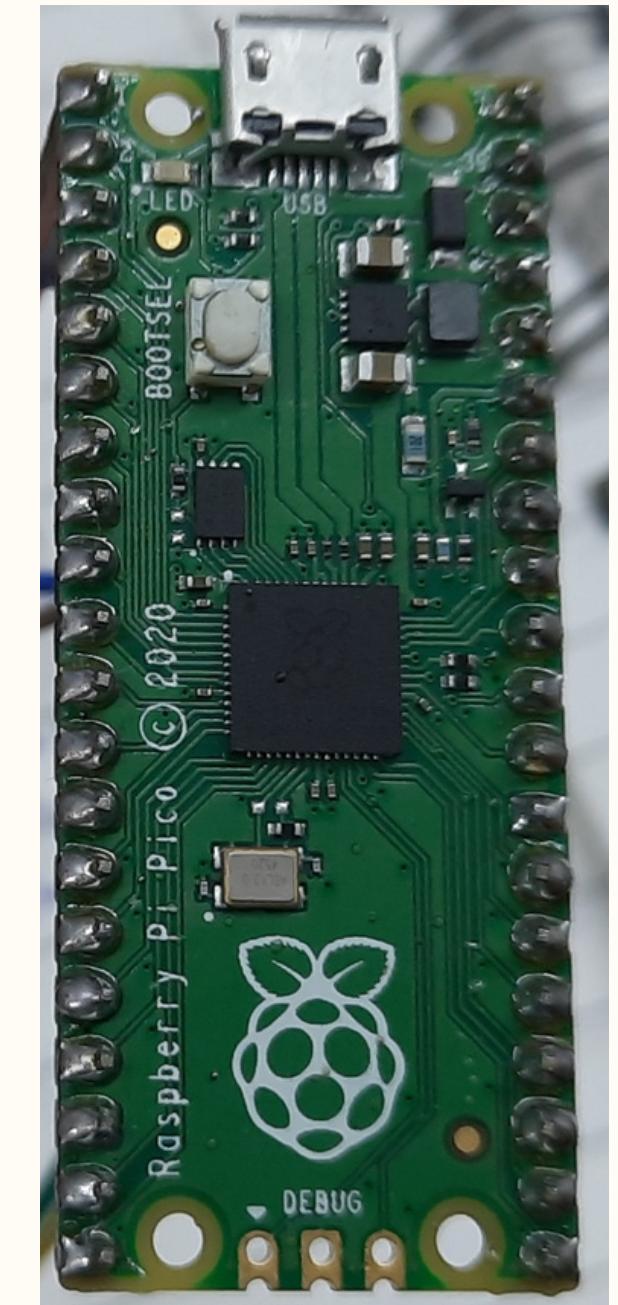


Motor Driver

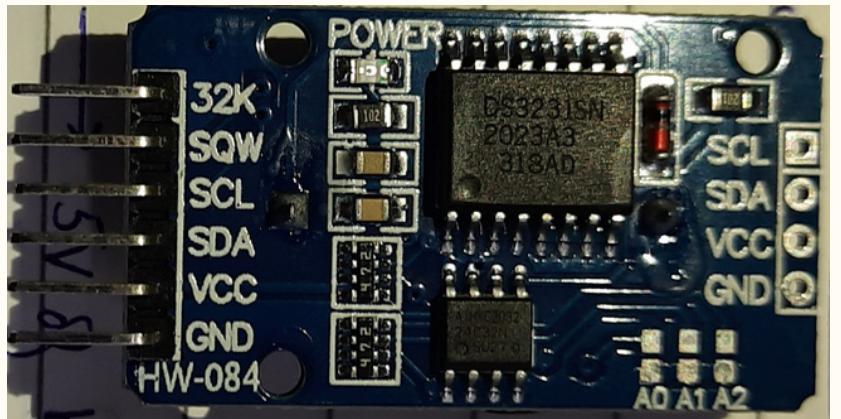


24C04 EEPROM

Version 4.0-Pico With
Potentiometer



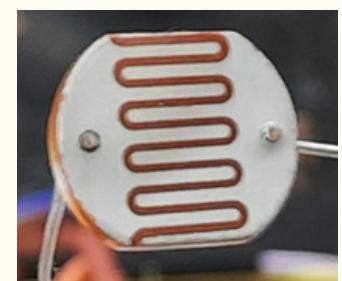
Raspberry Pi Pico



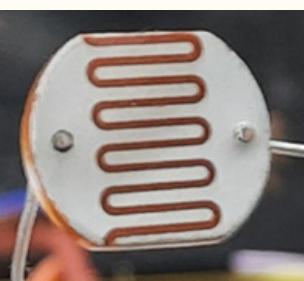
DS3231 RTC chip
Real Time Clock Module



Potentiometer



Light Dependent Resistors



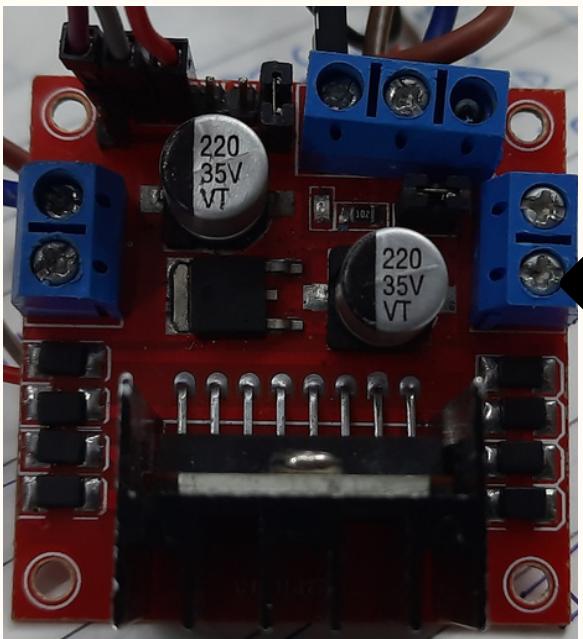
Working

- In Calibration Mode, the change made in the reading of the potentiometer is stored in EEPROM, when the linear actuator moves according to the difference found in LDR readings.
- In this version potentiometer reading varies because it is attached to the frame and it rotates when the linear actuator moves.
- For Daily Mode, the reading along with the time is read and the linear actuator is commanded to optimize Solar Panel's position, ignoring LDR readings.

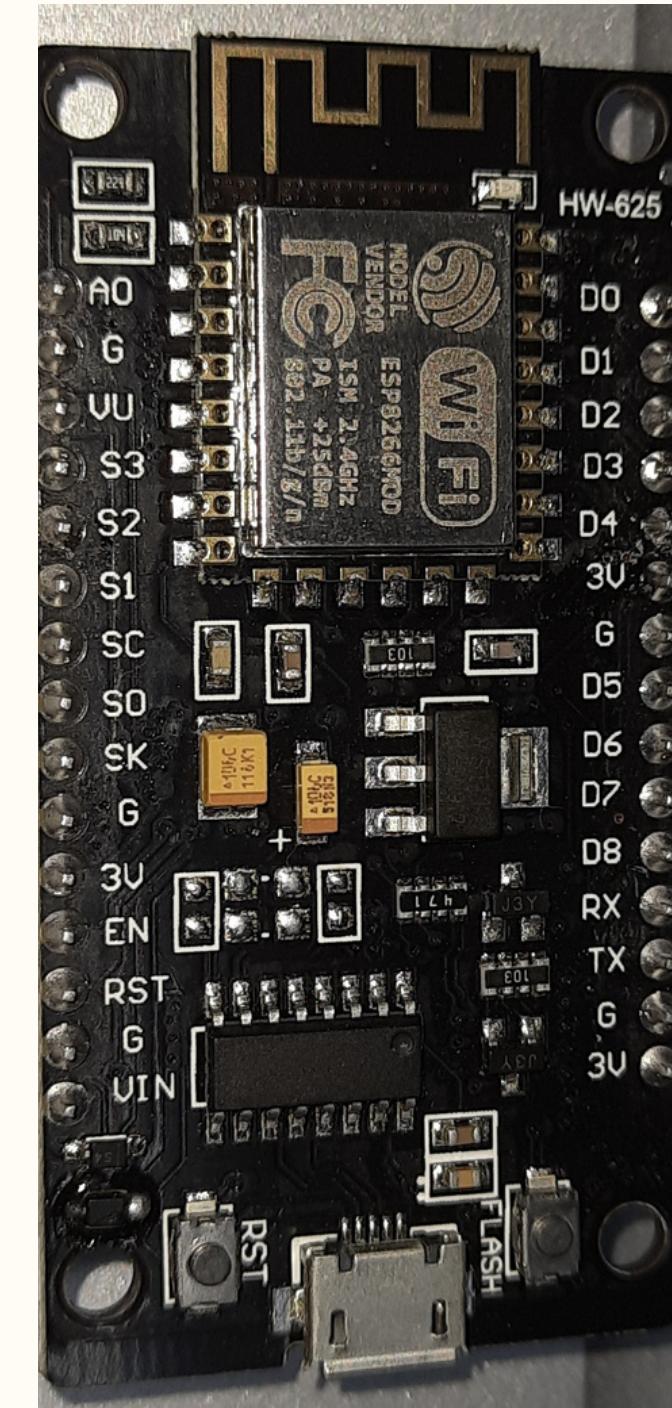
Version 5.0-ESP8266 with API



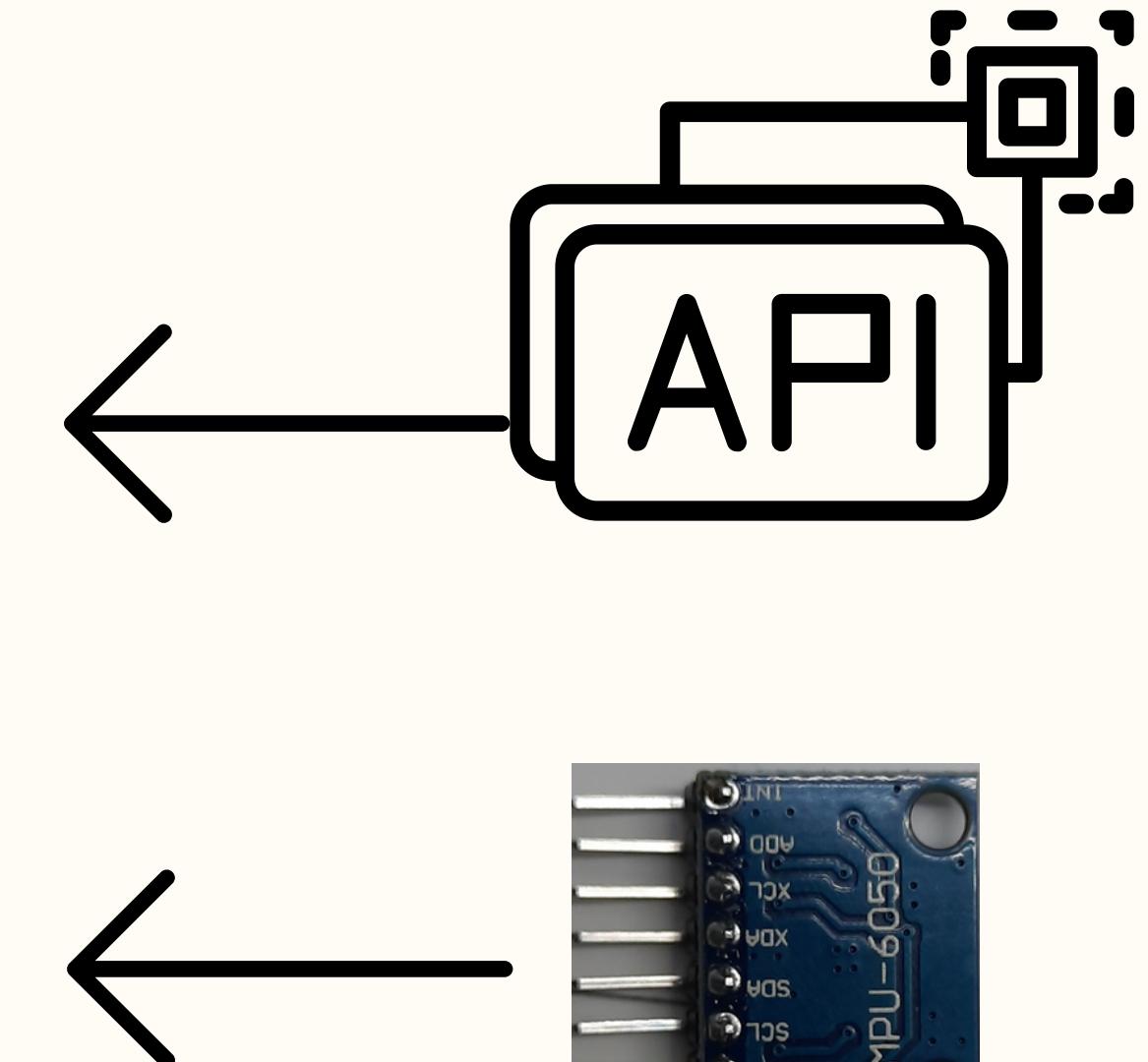
Linear Actuator



Motor Driver



ESP8266-Wifi Module



MPU6050 sensor
3-axis Gyroscope and 3-axis Accelerometer

Working

- In this Version, We take data from a weather website i.e. timeanddate.com in real-time.

The screenshot shows a web browser displaying the timeanddate.com website for Navi Mumbai, Maharashtra, India. The page title is "Navi Mumbai, Maharashtra, India — Sunrise, Sunset, and Daylength, July 2022". The main content area includes tabs for "Sun & Moon Today", "Sunrise & Sunset" (which is selected), "Moonrise & Moonset", "Moon Phases", "Eclipses", and "Night Sky". On the left, there is a large yellow circle icon labeled "Daylight" with the text "06:10 – 19:17" and "13 hours, 7 minutes". To the right, a list of current astronomical data is provided:

- Current Time: 21 Jul 2022, 11:19:04
- Sun Direction: 82.29° E →
- Sun Altitude: 69.91°
- Sun Distance: 152.008 million km
- Next Equinox: 23 Sep 2022 06:33 (Autumnal)
- Sunrise Today: 06:10 → 68° East
- Sunset Today: 19:17 ↙ 292° Northwest

A small world map is visible on the right side of the page.

API- ThingSpeak

- Using an API provider such as ThingHTTP from Thingspeak we make an interface to acquire data from the Website and use it here.

The screenshot shows the ThingSpeak website with a blue header bar containing the logo, navigation links (Channels, Apps, Devices, Support), and user account information. Below the header, a breadcrumb trail indicates the current page: Apps / ThingHTTP / SunAltitude. A green button labeled "Edit ThingHTTP" is visible. The main content area displays configuration settings for the "SunAltitude" app:

Name:	SunAltitude
API Key:	D13UPIO33ATKCCW6
URL:	https://www.timeanddate.com/sun/india/navi-mumbai
HTTP Auth Username:	
HTTP Auth Password:	
Method:	GET
Content Type:	
HTTP Version:	1.0
Host:	
Headers:	
Body:	
Parse String:	//[@id="sunalt"]
Created:	2022-07-04 7:01 am

To the right of the configuration form, there is a "Help" section with a URL for sending requests: `GET https://api.thingspeak.com/apps/thinghttp/send_request?api_key=D13UPIO33ATKCCW6`. A "Learn More" link is also present in this section.

Working

- Then the acquired data is used as required.



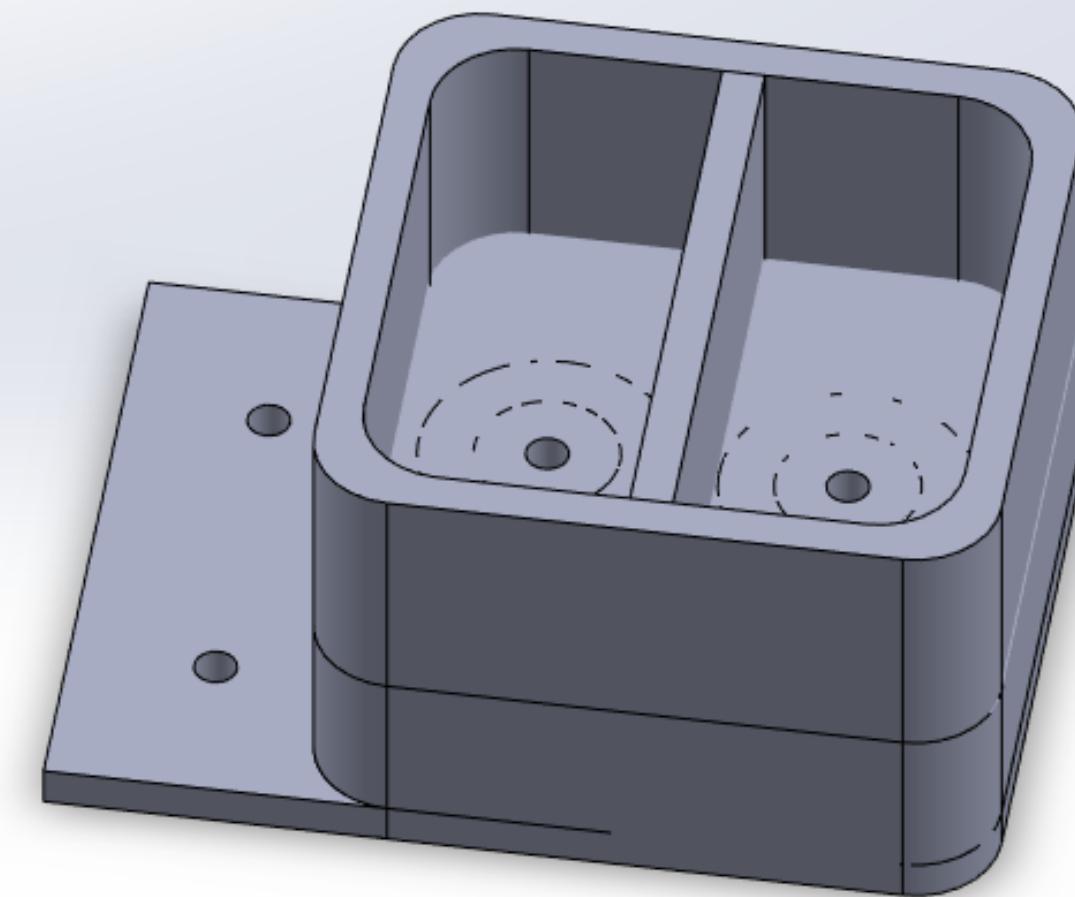
The screenshot shows a terminal window with a dark grey header bar containing the text "COM16" and a green circular icon with two white arrows. The main body of the window is a white text area displaying the following log output:

```
12:54:59.581 -> .....
12:55:02.801 -> WiFi connected
12:55:02.801 -> IP address:
12:55:02.801 -> 192.168.156.35
12:55:02.801 -> New Reading:
12:55:07.783 -> 86.70
12:55:10.169 -> Z: 88.00
12:55:10.169 -> down
12:55:10.169 -> New Reading:
12:55:15.036 -> 86.70
12:55:17.017 -> Z: 84.00
12:55:17.017 -> up
12:55:17.017 -> New Reading:
12:55:22.162 -> 86.70
```

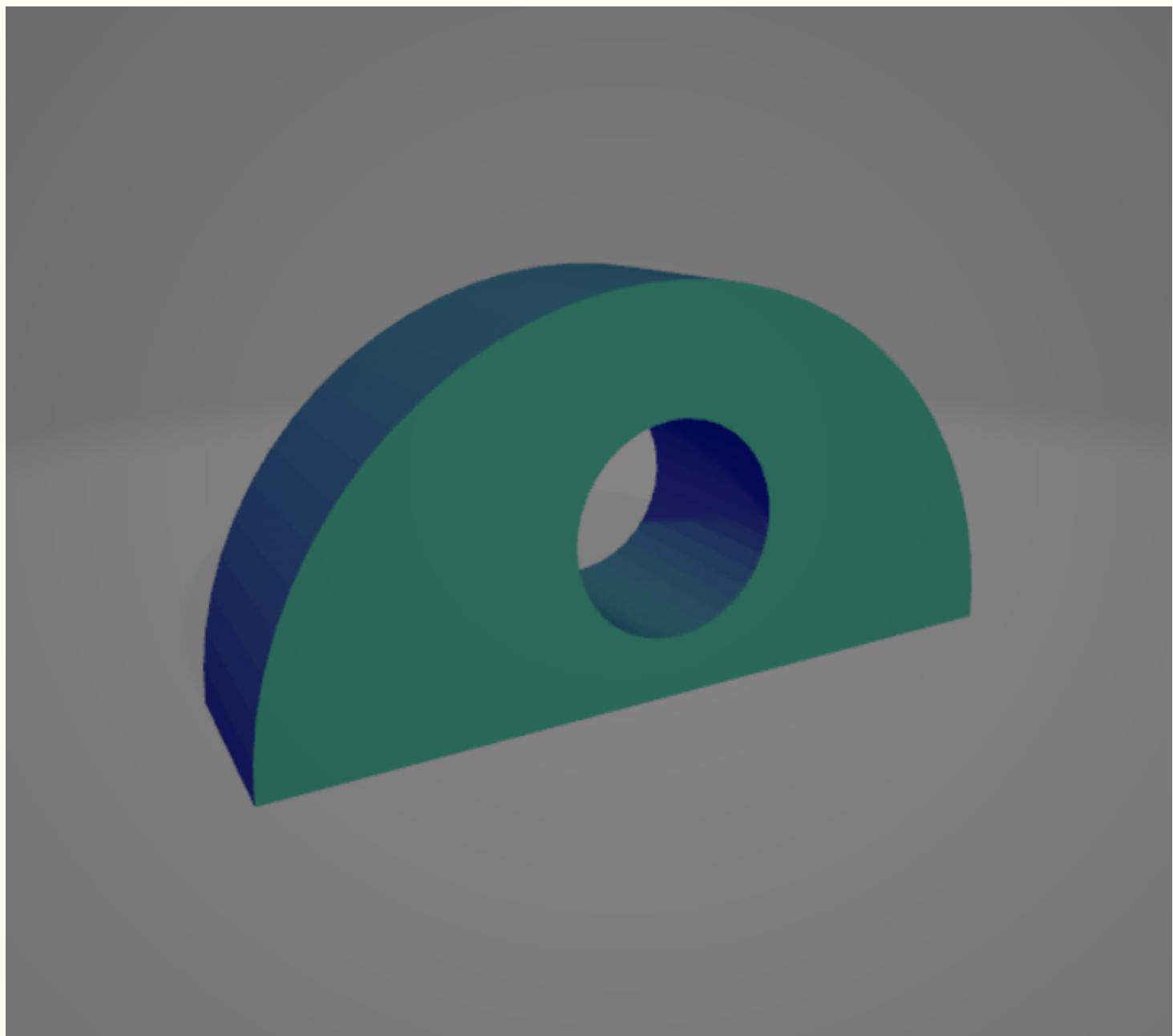
CAD Modelled Parts

We designed 2 parts in SolidWorks for the purpose of Fabricating the actual frame:

- **LDR Enclosure:** The enclosure was needed to protect the LDRs from the external environment. As LDRs are sensitive sensors they need to be protected from over-exposure and dust to prevent inefficiency. Another major purpose served by the enclosure was to have a dividing wall in between the 2 LDRs to create a substantial difference in the readings to make the logic and code run smoother.



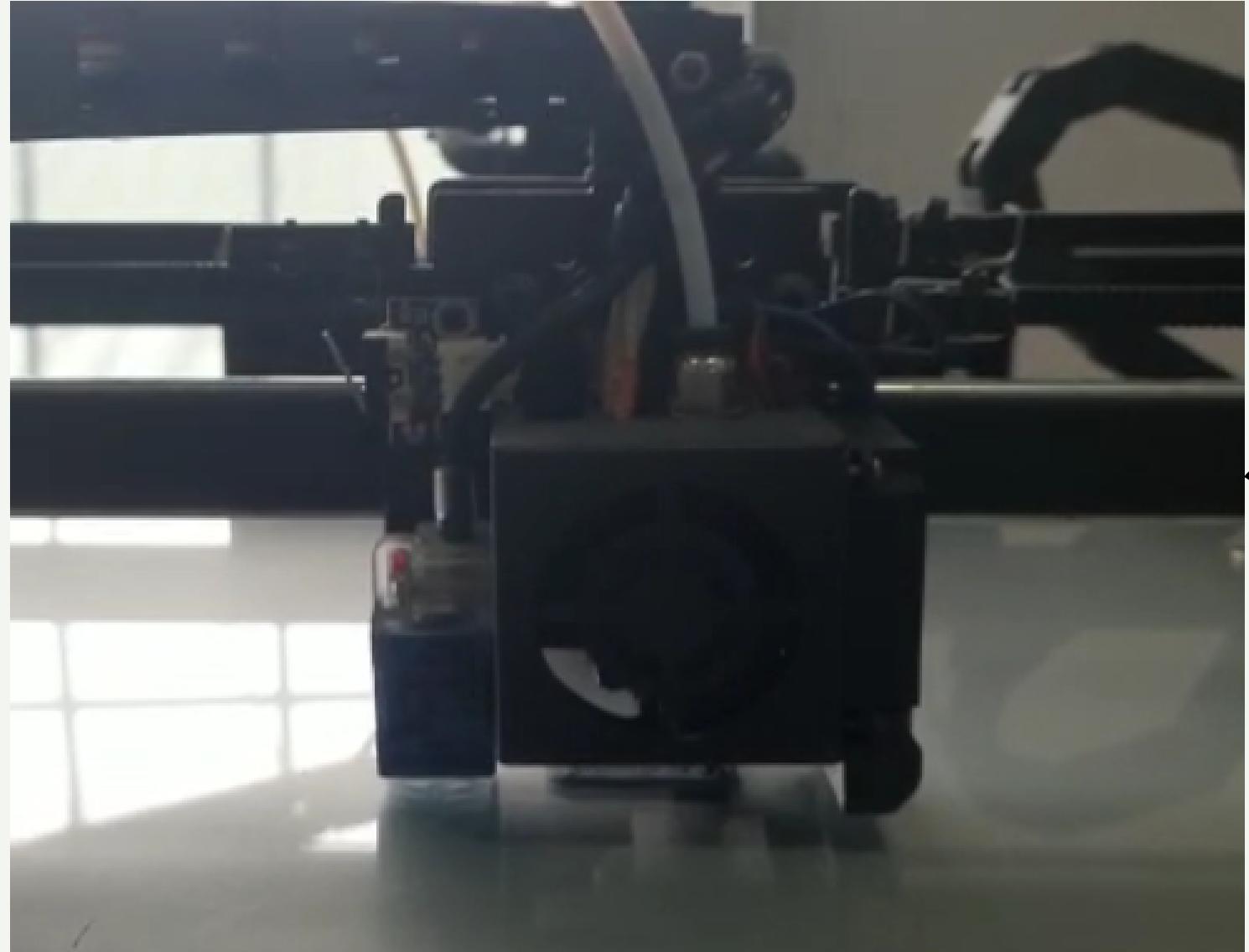
- **Potentiometer Attachment:** We had to incorporate the movement of the linear actuator with the movement of the potentiometer. We designed to use the linear motion of the linear actuator, which produces the angular motion in the solar panel to give us the desired revolutionary motion in the potentiometer component. Therefore this adjustment was designed to be fitted on the frame with the potentiometer sliding into the hole



Setbacks

We experienced 2 major setbacks:

- **MPU6050 Malfunction:** We had to change the entire approach by incorporating a Potentiometer instead and therefore plan the necessary frame changes.
- **3D printer motor/nozzle Jam:** This caused halting of the manufacturing process.



Results

- We developed 5 Versions of Single Axis Solar Trackers with the help of 3 Microcontrollers available to us. We incorporated different components to produce a variety of products to suit different needs based on budget and accessibility.
- All the codes have been verified and documented for further development and integration with manufactured parts.
- Manufacturing of the 4.0 version was underway but was halted due to the jamming of the 3D printer nozzle.
- File parts have been shared and can be printed when the needed servicing is done

All the Different Versions of Code

main - PS1_PramalInstruments / SolarTracker / Final_Code /		
		Go to file
sakshamssy PicoVersionWithMPU		3a94523 2 minutes ago
..		
FinalCode_For_ESPVersion	ESP Code Finalized	23 hours ago
FinalCode_For_ESPVersion_forTestingWithoutMPU	ESP Code Finalized	23 hours ago
FinalCode_For_PicoVersion	final changes	yesterday
FinalCode_For_PicoVersion_MPUS	PicoVersionWithMPU	2 minutes ago
FinalCode_For_PicoVersion_TestingCode	final changes	yesterday
FinalCode_For_PicoVersion_TestingCode_MPUS	PicoVersionWithMPU	2 minutes ago
FinalCode_SimpleTracker	Wrote Final Code For Simple Tracker	7 days ago
FinalCode_SimplestTracker	Update Code for Simplest Tracker	7 days ago
SetTimeforRTC_ToBeUsed_ToSetTime	FinalCodeForPicoVersion_Written	7 days ago

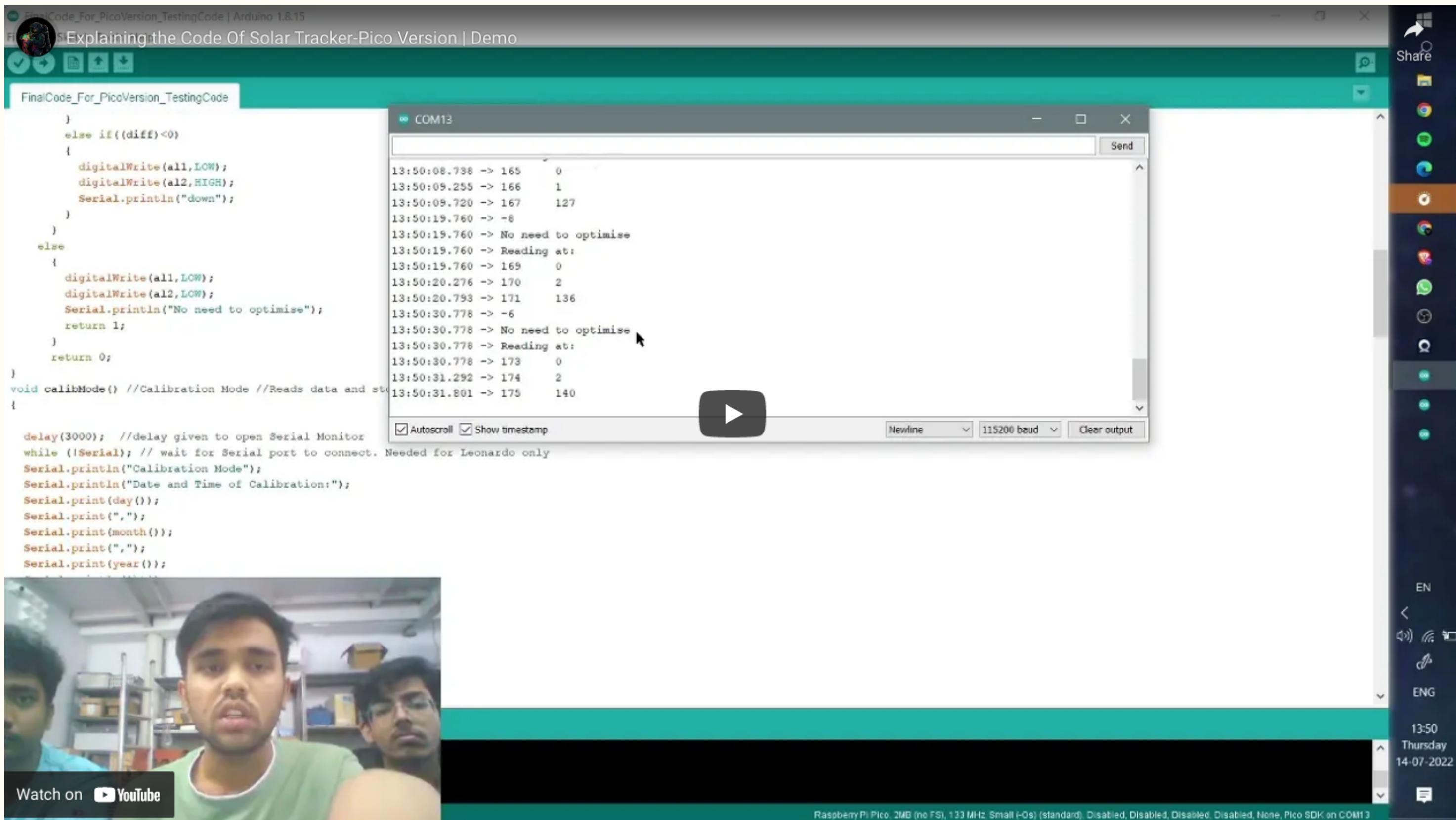
Testing Codes For Individual Components

Recent Activity		
 sakshamssy	ESP Code Finalized	c122cea 3 days ago
...		
 ESPVersion_JustAPI	ESP Code Finalized	3 days ago
 GetAllData_mpu6050	ESP Version Completed	3 days ago
 LinearActuator_Test	Folder Rearrangement	15 days ago
 eeprom_read_write_NewCode_Works	few renaming changes	15 days ago
 esp_https_get_from_api	Folder Rearrangement	15 days ago
 i2cscan_nano	Folder Rearrangement	15 days ago
 ldr_DIFF	Folder Rearrangement	15 days ago
 linearActuator	Folder Rearrangement	15 days ago
 rtc2	few renaming changes	15 days ago
 rtc_setup	few renaming changes	15 days ago
 i2cScan.py	Folder Rearrangement	15 days ago

Learning Gathered at the End of PS-I

- Working and coding in Arduino IDE software. All the versions were developed by setting up the particular environment for respective Microcontrollers.
- Hand developing circuits and then implementing them using a breadboard, jumper cables and components.
- Soldering wires and components to the PCB to make the circuits concise to work with(common industry practice).
- Working with a 3D printer, by developing and designing components in STL format and then physically printing them on the printer after doing the needed calibration.
- Working in a structured environment and as a member of a team in a formal workspace.

Demonstration



Summary & Conclusion

- Through this process, We got to learn about a variety of electronic components and various libraries related to them.
- We learnt about incorporating components and choosing components, the way it happens in the industry.
- We learnt the whole process through which work is commenced in the R&D department of a company like Prama Instruments Pvt Ltd.

Acknowledgements

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Documentation:



github

https://github.com/sakshamssy/PS1_Pramalnstruments



Google Drive

https://drive.google.com/drive/folders/1XIVC2Eu_QBowvHRujOVyv8xm8NT41PD?usp=sharing

Documentation:



PRACTICE SCHOOL-1

- SOLAR TRACKER
- OCCUPANCY SENSOR

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GitHub